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Tools for Agriculture: A Buyer's Guide to Appropriate Equipment

introduction by Ian Caruthers

Published by:

Intermediate Technology Development Group (ITDG)

Available from:

Intermediate Technology Publications
9 King Street
London WC2E 8HN
ENGLAND

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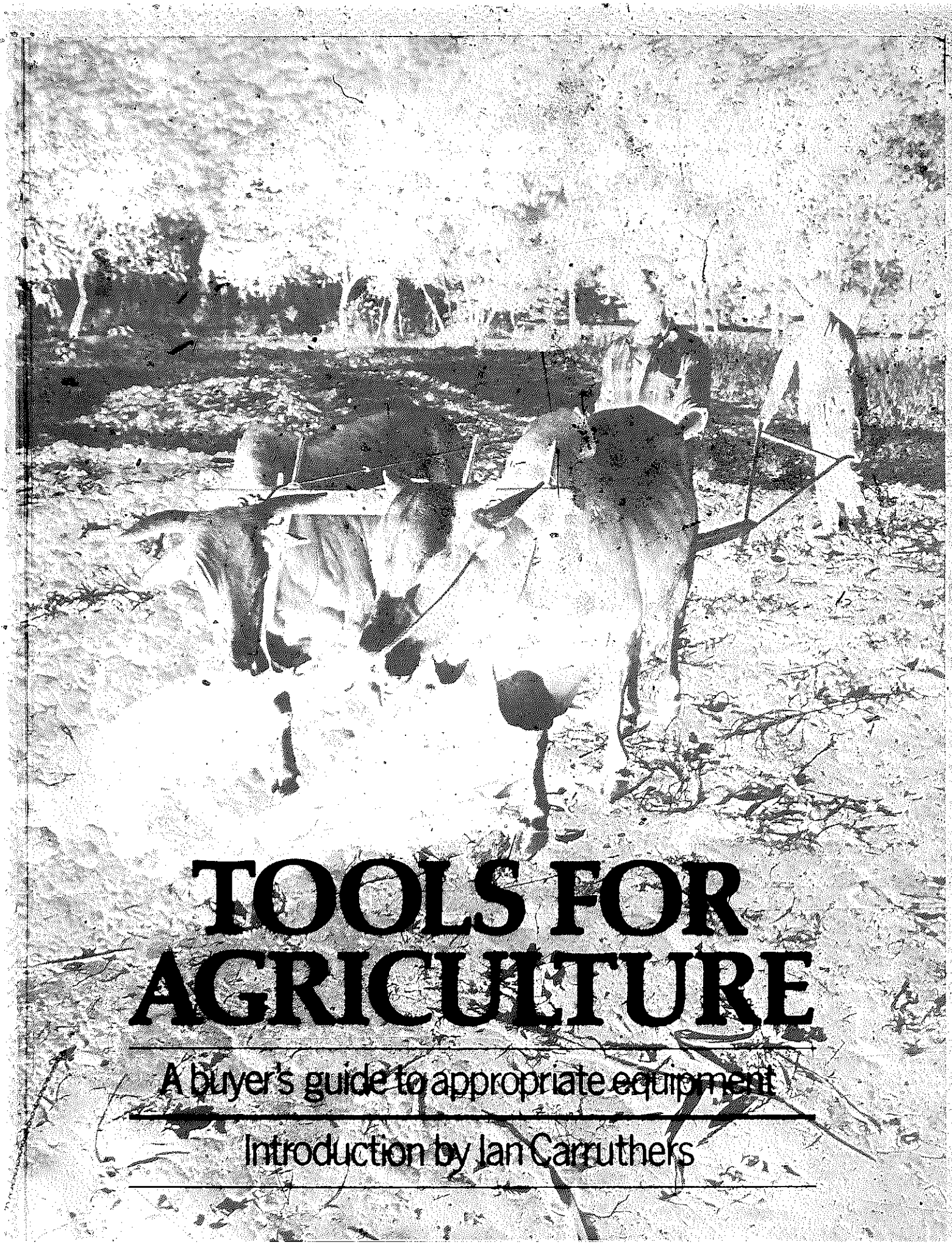

TOOLS FOR AGRICULTURE

A buyer's guide to appropriate equipment

Introduction by Ian Carruthers

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Third Edition

I.T. Publications *in association with* GTZ/GATE • 1985

Intermediate Technology Publications Ltd.
9 King Street, London WC2 8HW, UK

This edition of *Tools for Agriculture* has been assembled by a team led by Patrick Mulvany, Agriculture Officer of ITDG. The team drew on help and advice from a large number of individuals and organizations; it has not been possible to thank or acknowledge them all in the Acknowledgements on page vii, and the compilers, and the publishers, would therefore like to record here their general thanks for all assistance given.

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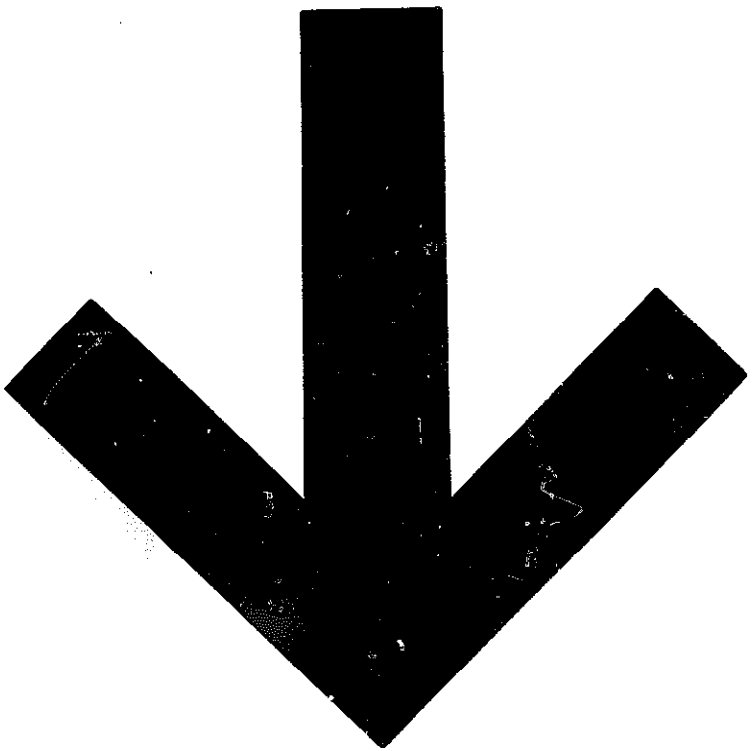
Tools For Progress — first published 1967
Tools For Agriculture — first published 1973
2nd edition 1976
Reprinted 1979
Reprinted 1981
3rd edition 1985

Cover photograph copyright Oxfam/Jeremy Hartley

ISBN 0 946688 36 2

Printed by the Russell Press Ltd, Gamble Street, Nottingham NG7 4ET, UK



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HOW TO USE THIS GUIDE

It is intended the guide should be used by the following categories of people:

- Farmers' representatives who purchase equipment on behalf of their clients;
- Advisers who seek to assist farmers and farmers' organizations with the purchase of equipment;
- Development Agency personnel who need to purchase equipment on behalf of farmers and farmers' organizations;
- Prospective manufacturers or manufacturers' agents who wish to have information on the range of equipment currently available.
- Development workers, students and others who wish to learn about the types of equipment available.

We expect the reader to use the guide in one of the following ways:

- to find the name and address of the manufacturer of a specific piece of equipment whose generic name is known e.g. a treadle-operated rice thresher or an animal-drawn turnwrest plough.
- to find the name and address of the manufacturer of a piece of equipment whose general purpose is known e.g. a machine for threshing rice or soil tillage equipment.
- to find out about specific types of equipment or equipment used for specific purposes.
- to find out about the range of equipment available from specific manufacturers or manufacturers in particular countries.
- to learn more about equipment used for the different aspects of crop and livestock production and processing.

To help the reader find the information needed as quickly as possible the material has been clearly labelled and indexed, and laid out as follows:

- *The Contents Page* will guide the reader to one of thirteen sections;
- *The Manufacturers' Index* gives the page numbers of equipment supplied by a particular manufacturer. This index includes telephone/telex numbers where available, and is organized in alphabetical order by country, e.g.:

INDIA

ACHIEVE ENGINEERING WORKS, *103*
C-294 Peenya Industrial Estate
Bangalore 560 058
Karnataka

ADROIT INDUSTRIES, *103*
19-B Industrial Area
Richhai Jabalpur
Madhya Pradesh

- *The Equipment Index* gives the page numbers of specific or generic types of equipment listed under their generic and functional names, e.g:

Maize:
- driers *147*
- graders *133*
- huskers *133, 135, 154*
- mills *154, 240*
- planters *61*
- shellers:
  - hand-operated *133, 134*
  - bicycle-powered *134*
  - motorized *135, 136, 137, 154*

- *The Section Headings* and accompanying photograph give the title and indicate the contents of each section;
- *The Page Headings* indicates the contents of each page, or at least some of the major items on each page;
- The *Sources of Further Information* pages gives the names of manufacturers who we understand to be producing equipment of the general type indicated. These are listed within equipment-type country by country.

Within each section the information is presented in three ways:

- A clear *Introduction* which lays out the most important points to bear in mind when purchasing a particular type of equipment. (The emphases vary from section to section — showing the difficulty of decision-making when selecting equipment for smallholder agriculture).
- *Comprehensive Tables* which list the manufacturers of certain types of equipment and give some further information about specific items, or the range of items manufactured. In many tables it was impossible to give the full address of the manufacturer and the reader is referred for these to the Manufacturers' Index.
- Pages laid out in a grid pattern in which the compiler has attempted to present the equipment in a logical order, that in which the operations are carried out, and within each type of operation the progress is from hand-operated, through animal-drawn, to motorized equipment. Sometimes one particular type of equipment is illustrated to represent a group — many of which may differ in detail, though not in their use. Wherever possible the trade name of the equipment is used, in order to facilitate enquiries to the manufacturers.

Having located a manufacturer for the type of equipment in which you are interested, we suggest you write direct to the manufacturer for further details: current prices, availability, delivery times and so on. (Remember that, where known, telephone and telex numbers have been included in the manufacturers' index.)

Every attempt has been made to ensure accuracy of the details presented in this guide, but doubtless changes will have occurred about which the compilers are unaware. We apologize to any reader to whom we may have given a false lead. A note will be made of up-to-date information which becomes available to ITDG.

It must be stressed that this guide relies on information supplied by the manufacturers and that inclusion of an item is no guarantee of performance. Whilst every care has been taken to ensure the accuracy of the data in this guide, the publishers and compilers cannot accept responsibility for any errors which may have occurred. In this connection it should be noted that specifications are subject to change without notice and should be confirmed when making enquiries and placing orders with suppliers.

PREFACE

During the past five years GATE has been operating an International Question and Answer Service in the field of appropriate technology. From all over the world our team has received thousands of letters asking for help in identifying small-scale, low-cost technology for rural development. While in the early years the emphasis was clearly on energy problems, we feel that today there is a growing demand for information on technology alternatives on the level of small-scale farming. More and more, agricultural implements, tools and items of equipment have shifted into the centre of attention.

Information on such subjects is, however, hard to get: if you want to buy a 90-hp tractor you can find the appropriate information almost everywhere in the world, but if you look for simple, small-scale equipment you are lost. In fact, the earlier editions of *Tools for Agriculture* were almost the only source of external information GATE was able to rely on in answering questions about low-cost agricultural equipment and where it can be obtained. But catalogues like *Tools for Agriculture* are not just things to lean back on. They are like tools themselves, and from time to time they need sharpening up and renewing on the basis of experience.

ITDG proposed to produce a new catalogue, to be improved in a number of ways.

- to contain the most factual and most reliable information on manufacturers of small-scale equipment worldwide;
- to collect information from Third World countries in order to establish direct south-to-south trade relations — instead of technical hardware to place the actual user in the centre of attention by actually helping him or her to *obtain* suitable equipment (introductions to each topic, cross-referencing etc.) rather than just identifying it.

The production of such a catalogue could not be managed by GATE on its own, and we were therefore very pleased when ITDG suggested co-operation. Apart from sharing the burden of costs, we pledged to collect information from German-speaking countries in Europe (the Federal Republic of Germany, Switzerland, Austria) and to contribute whatever information GTZ had in its own files. At the end the project turned out to be an enjoyable exercise in co-operation, both with ITDG and between GATE's own departments.

Of course, in a book of this kind, we cannot treat the various topics comprehensively and errors can not be totally avoided. But even so, we hope the book will serve the purpose it was made for: to be a tool on its own, a tool which you, the reader, can use in order to improve rural development.

Heinz Ströter, Head of Department, GTZ/GATE,
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ABOUT THIS GUIDE

In 1965 the Intermediate Technology Development Group prepared its first guide to UK manufacturers of small-scale agricultural equipment and since then ITDG has regularly published 'Buyer's Guides'. *Tools for Agriculture*, the last edition of this guide, was published in 1976, and presented information on some 700 products manufactured by about 250 manufacturers worldwide.

This guide is intended to assist the prospective buyer in a rational choice of equipment. It presents a greater range of equipment, both in the numbers of manufacturers and countries covered and in terms of types of equipment, placing different emphasis on the kind of information presented. Whilst the coverage of equipment for pesticides application (for example) has been compressed, the coverage of livestock production equipment has been greatly expanded compared with previous editions. Furthermore, specific sections on Wool harvesting and Beekeeping were included after considering the range of livestock production activities which are most widespread and beneficial to lower income groups — these two were selected because the available range of equipment represents a suitable, intermediate, level of technology.

The process of compiling the guide started with requests being sent to a list of some 6,000 manufacturers, asking for information about their products. The response was disappointing and further letters were sent to a selected group of manufacturers.

Then, after careful investigation of secondary sources, additional product information was added to the data bank. Although by no means exhaustive, the guide will provide the reader with as much information as is reasonably available. Readers should understand that we have not necessarily included all the products available from the listed manufacturers.

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ACKNOWLEDGEMENTS

A guide of this type cannot be compiled without the efforts of many people. The source data for the book have been provided by hundreds of companies around the world who took the trouble to respond to our letters. We are grateful to them and to those who supplied drawings or photographs. We also thank the firms who replied but whose equipment was outside the scope of this guide.

There is not room to mention everyone who has helped but we would particularly like to thank the 13 authors who wrote the introductions; Jane Swinton, the Editorial Assistant; advisers, Bryan Morgan, Tony Moody, Thomas Kuby and, in particular, Eduardo Busquets; Susan Batchelor, Peter Young, Phil Clarke, Alan Cocks and Jenny Trussell for the illustrations; Howard Bell, Adrian and Catherine Cullis, Lynne and Tim Fellows, Barbara Norris, Tim Ogborn, John White and Michael Selby-Green, writers; Victor Ambrus, Dr. Wu, John Burton, Chris Levin, Ian Grant, Mike Hogarth, Clement Willens and Christine O'Brien for translation work; Ruth Ryley, amongst others, for her typing and checking, and colleagues at ITDG for their support, particularly Dr Marilyn Carr and John Collett. Thanks are also due to the embassies and high commissions of the many countries whose products are recorded. We are also particularly grateful to those who provided financial support during the preparation and publication of the book, particularly for the substantial help received from the Overseas Development Administration of the British Government, the Swedish International Development Authority (SIDA) and Barclays International Development Fund.

GENERAL INTRODUCTION

Problems of farmers in developing countries

The main economic characteristic of agriculture in developing countries is the low level of productivity compared with what is technically possible. It has been shown in many and varied circumstances that although farmers may be rational and intelligent, technological stagnation or slow improvements can still be the norm. This contradiction can be explained by understanding several unusual, troublesome features of agriculture. First, because agriculture is basically a biological process, it is subject to the various unique risks of weather, pests and disease which can affect the product supply in an unpredictable fashion. Despite exceptional biological risks, most farmers nowadays rely to various extents upon cash derived from sales of produce. But agricultural products have consumer demand patterns which can turn even good production years — when biological constraints are conquered — into glut years and therefore financial disasters. The biological nature of production also results in a large time-gap, often months or even years, between the expenditure of effort or cash and the returns. Once cash inputs are used, an unusually high proportion of working capital is required, compared with industry. The final problems created by the biological nature of production lie in the marked seasonality. The peaks of labour input create management problems, and perishable commodities are produced intermittently; both create additional financial and technical storage problems.

A second characteristic of agriculture is from the small scale of most farming operations, often coupled with a low standard of education of the operators, which gives farmers little economic power as individuals and little aptitude to seek such remedial measures as do exist. There are many examples of appropriate technology but small farmers will often need intermediaries, such as extension workers and project personnel, to open their eyes to the potentialities. Given the vulnerability of small farmers to biological and economic risks, those intermediaries have special responsibility to assess the impact of any new technology for each particular set of local circumstances.

A third factor which affects efficiency in agriculture is a political one. It is in some ways ironic that in countries with very large numbers of small farmers, producers tend to command little political power despite their combined voting strength. Indeed they are often seen as the group to be directly and indirectly taxed to support other, generally urban-based, state activities. As a contrast, in rich countries, we often see minorities of farmers with little voting power receiving massive state subsidies, much of which supports technological advancement. The rationale of farmers referred to above thus leads to the exploited, small farmers producing well below potential and the rich, large-scale farmers producing food mountains that can only be sold at further subsidized prices.

The 1970s food crisis, the recent failure of agriculture to match rising food demands in many countries, particularly in sub-Sahara Africa, and the failure of industry to fulfil its promise of creating employment and wealth has turned the attention of policy-makers back to the long neglected and often despised agriculture sector. New technology for the large number of low-income, small-scale, poorly educated farmers will be necessary if agriculture's enhanced role is to be successful.

What are the technology options?

Innovation and technology change has been and will be the main engine of agricultural development. Technology

(Photo opposite: J. Hartley)

Innovative equipment can be simple in construction: a four-furrow row seeder.

change can be described as the growth of 'know how' (and research as 'know why'). But technology is not just a system of knowledge which can be applied to various elements of agricultural or other production to improve levels or efficiency of output. Technology application requires and uses new inputs. In contrast, technique improvement is the more difficult art of improving production essentially with existing resources. Pity the poor agricultural extension worker sent out to advise experienced farmers with no new technology, but only improvements in technique to demonstrate!

It is possible to exaggerate the lack of prospect for improvement and the consequent need for new investment in farm resource use. Changes both on and off-farm are influencing the economies of traditional systems. For example, with farm size halving every twenty years or so in some regions — as a result of population growth, and with increasing demand for cash from farming activities for production items such as seed (which used to be farm produced) or for consumption items such as radio batteries and so forth, there are new challenges to the traditional rationale and the old system optima. But despite the need to adjust the existing resources to find new optima, the opportunities for really big gains will undoubtedly come from new technology which will often require radically different ways of doing things. A change in the resource base or the injection of a new piece of technology into an interdependent agricultural system may alter various other constraints and opportunities within the overall farm system. One function of a reference book such as this is to act as an encyclopaedia illustrating alternative ways of coping with new challenges. Readers do not have to reinvent the wheel each time a new transport system emerges. Self-reliance has little merit over technology transfer when it comes to solving food availability problems in a rapidly changing world.

This book displays a very wide range of technology and describes both what the technology can achieve, and how and where most information can be discovered. It shows that there is already in existence a mass of tested technology for small-scale farmers. The farm technology itself is laden with opportunities for improving the returns to land, water, labour and other crucial resources. The careful farmer, with help, can have many options.

The role of information

In the theory of classical economics, information on the contents of the technology itself is assumed to be a free good, readily available to all. This is clearly absurd in any industry, but particularly so in agriculture. One of the main justifications for public support of agricultural research and extension, in developed and developing countries alike, is the inability of farmers to search and experiment efficiently and thus to find out what technology is available.

However, knowledge of the existence of appropriate technology will not be sufficient to ensure adoption. Attitudes toward it may need to change, the hardware has to be physically available and those convinced of its value need financial resources to acquire it. One good example of this is family planning technology, where knowledge has generally outrun the capacity of the delivery systems. Similarly, local testing of the appropriateness of various items is very desirable. This in turn, will require more local agricultural research stations to accept responsibility for adaptive research and technology testing. Nevertheless, knowledge is obviously a necessary prerequisite to adoption, and publications such as this have an important part to play in information dissemination.

The impact of technology

Selection of technology for inclusion in this book does not imply endorsement of a particular product. Indeed, supporters of the appropriate technology concept often have an ambivalent attitude to new technology. New technology always changes the system and in particular it is likely to change who benefits from it. Appropriate technology advocates believe the kind of cheap, simple, small-scale, locally produced, reliable or at least mendable technology will increase incomes and improve or at least avoid worsening income distribution. This is possible, but it is still hard to prove that any technology has the ideal intrinsic qualities that will somehow create wealth and at the same time favour the poorest groups in society. On the contrary, experience shows that the income-distribution consequences of change are generally unpredictable. Since new technology normally requires access to resources, it generally favours the better off; the mode of use of technology, and thus its impact, is not a readily visible quality.

To reject all modern technology on grounds related to fears about income distribution is to argue like the elderly man who said that 'if God had meant us to fly He would not have given us railways'. Societies must accept the benefits of new technology and devise means to reduce the social costs associated with any worsening of income distribution — the greater the gain in aggregate income from innovation, the easier this should be to achieve. We are aware that the direct users of the book will seldom be the small farmer client that the contributors and compilers generally have in mind in selecting equipment. But those who have access to this book, such as extension officers, government officials,

FAO

Well-designed hand tools can reduce drudgery: harvesting in Morocco.

teachers and local leaders must give guidance with care and with wisdom.

How to choose

In selecting new technology, either for testing or promotion, numerous criteria can be devised to aid judgement. These will include the degree of technical effectiveness, financial profitability, the economic and social returns, health and safety factors, the administrative and legal compatibility with existing conditions. The criteria will not necessarily be independent or even compatible. A financially profitable piece of technology may depend upon underpriced foreign exchange or tax allowances and be economically unattractive. It may substitute capital expenditure on machinery for labour and be socially unattractive. A particular criterion such as technical efficiency, may have several elements to aid judgement — such as the technology's simplicity and labour-intensity, its ecological appropriateness, its scale and flexibility, its complementarity with existing technology and so forth. These elements are not inherently equal and in some circumstances one will be regarded as carrying most weight, in other circumstances another. Choice of technology is a matter of judgement and all the modern aids for technology assessment, for cost-benefit analysis and the like cannot hide this fact. Analysis is an aid to and not a substitute for judgement; the social consequences — which are agonising — must be weighed against the various real benefits that are apparent.

The technologies presented in this book reflect the belief that whilst all technology will alter the economic status of large numbers of people (often in the direction of greater inequality of income, greater commercialization, more wage labour and increasing landlessness) some technologies are more likely to do so than others. You will find few tractors or combine harvesters in this book, for example, but great emphasis on, for example, animal-drawn tool-bars and powered threshers. Technology varies in its degree of reach-down to the low-income farming groups who, if they are not the main target of rural development, are from our viewpoint a key component. The cost of lost output through using less efficient equipment — hand pumps rather than tube-wells, resistant seed rather than crop protection, hand tools rather than tractors, small livestock rather than cattle and buffaloes — is small. Indeed, the productivity of labour-intensive gardening and allotments can often exceed that of modern capital-intensive farming systems — as was shown in Britain during and after the Second World War. Whilst situations do occur where demand for increased food supplies force governments to chase home-produced food without too much thought about the social impact of the production system, such dire circumstances are rare. They might occur where the bulk of low-income people are food purchasers — urban dwellers and landless rural labourers, and in these cases large-scale, capital-intensive state or private farming with the most modern technology, might be justified. But it is only rarely that the trade-off between technical and economic efficiency and equity criteria is painful. Research in many countries has shown that modernized peasant-based systems are generally equally or more efficient and to most views more equitable, and thus it is the small farmers who are seen as the main beneficiaries of *Tools for Agriculture* — even if they are unlikely themselves to be the main readers of this book.

Feedback

Whilst there are a number of people who know and understand the hardware described in this book, there is less understanding of the ways in which technologies are 'delivered', or options presented to the small farmers themselves. ITDG is therefore always pleased to have critical and appreciative feedback — from the aid agencies, extension workers, credit agencies, schoolteachers, businessmen, politicians and others who use this text, on the content and format, equipment that is missing, new problems, the effectiveness of the equipment, the service of the manufacturers, and new ideas for delivery. The hardware available grows rapidly in diversity and power, but, just like computers, it will be useless without the software support. In the case of agriculture, technology software stems from the efforts of interested individuals and groups who are close to the small farmers. We look forward to hearing from you!

Ian Carruthers
Wye College, University of London

STEPHEN BIGGS

Modern technology is easily applied, if one has the resources: fertilizing maize.

1. SEED-BED PREPARATION

Motorized rotary cultivator for rice.

Soil is cultivated in order to provide good conditions in which seeds will germinate and plants will grow to achieve maximum yields. These are effected by:

- Opening the soil structure for easy root development and infiltration of water.
- Cutting weed roots and burying green material to reduce crop losses from weed competition.
- Incorporating manure or chemical fertilizer.

Of all the agricultural tasks, cultivation can be the most demanding of time and energy; therefore it should not exceed the level necessary for the crop to thrive in a given soil, climate or farming system. For annual rain-fed crops the prime consideration is usually to establish plants as early as possible to achieve the longest possible growing season.

The time available for cultivation and planting depends upon the soil type, climate and cropping schedules. Soils which dry hard are often impenetrable with light tillage equipment until softened by rain. Cultivation at the end of the season when the soil is still moist can ease the problem. Only secondary tillage would then be required prior to the next planting. Unfortunately this may not be possible after long-season crops, such as cotton, because such land is usually hard by the end of harvest.

The time required for cultivation is determined by the ease with which tilth is produced and by the field production system, which in turn is governed by the labour and capital availability.

In areas where, early in the season, water is not a limiting factor, the control of weed growth is the principal problem. Poor weed control resulting from inadequate tillage can later cause partial abandonment of growing crops if the weeding techniques are unable to cope with the growth rate over the total area. However, in semi-arid areas water catchment and the reduction of evaporation loss are the most important considerations.

Hand Tools

When farming is restricted to that which can be achieved by manual labour, the area a farmer and family can manage is rarely more than 2 ha. Although labourers can often work ten or more hours per day, their physical effort may be limited by hot and humid weather, an inferior diet, and possible endemic disease. This commits them to little over subsistence farming, unless there is an opportunity to supply a high value market, and/or adequate water supply to allow more than one crop per year. An added problem for such farmers is that they rarely qualify for credit to enable the use of improved seeds and fertilizers.

Hand tools made from local materials to local designs, such as the digging or planting sticks used in Latin America and parts of Ethiopia, and the large spade-like device tipped with steel used in West Africa, are cheap and effective. Factory-made tools may last much longer and, under certain conditions, can be produced more cheaply. However, the method of operation may be so different from the traditional action that introduction is restricted.

Those farmers who buy factory-made hoes, albeit with a handle of traditional length made and fitted in the village, often limit their purchase to one size, even when several are available for alternative jobs. The time taken can be reduced and the tool-life maximized if they are used for the correct duties. Cultivation of dry, hard soils benefits from a thick but narrow hoe. General work, light cultivation and weeding is quick with a wide hoe, which may be the same weight as a narrow hoe but, being thinner, cannot withstand continued heavy work. For planting, a narrow, light hoe is preferable.

For a hoe to be acceptable it must conform to the local tradition for fitting handles. The most common methods of attachment are either a spiked tang or ring, forged as part of the blade, or sometimes welded or riveted to it. Despite the production limitations with hand tools, their use will always be necessary to supplement other low-powered methods of cultivation.

Animal-powered Cultivation

Primary tillage This is carried out to open compacted soil after a fallow or seasonal cropping, thus allowing soil aeration to assist root development and the release of nutrients, and easing the passage of water into the soil, preventing wasteful run-off. Animal-powered equipment available for this operation includes traditional ploughs, as well as steel ploughs and associated implements.

Traditional ploughs Animals operating wooden ploughs, often with a steel point or share, are used widely in Asia, particularly the Indian sub-continent, in the Middle East, North Africa, Ethiopia and Latin America. As a traditional system, the ploughs have evolved within localities to match the available wood, cultivation requirement, and animal physique. Wooden ploughs have a breaking action ideal for flood-irrigated rice production. They do not invert the soil or provide any of the appreciable weed control necessary in rain-fed agriculture but, because of their extremely low cost it is difficult to persuade farmers to invest in modern equipment. Wooden ploughs may, in difficult conditions, require up to five passes in different directions to obtain a satisfactory tilth. Trials in Ethiopia have shown that the local 'Maresha' requires twice the man-hours compared to modern animal-drawn equipment to establish crops of broadcast wheat and barley.

Traditional animal-drawn equipment is generally pulled by a wooden pole which is an integral part of the unit. The Ethiopian 'Maresha' is one of the few traditional implements which has a pitch adjustment to modify the penetration angle and adjust the depth of work. Traditional ploughs are often backed up by other traditional implements for breaking down and levelling seed beds, such as the 'ladder' used in Bangladesh, and a range of animal-drawn puddling devices for irrigated rice paddies.

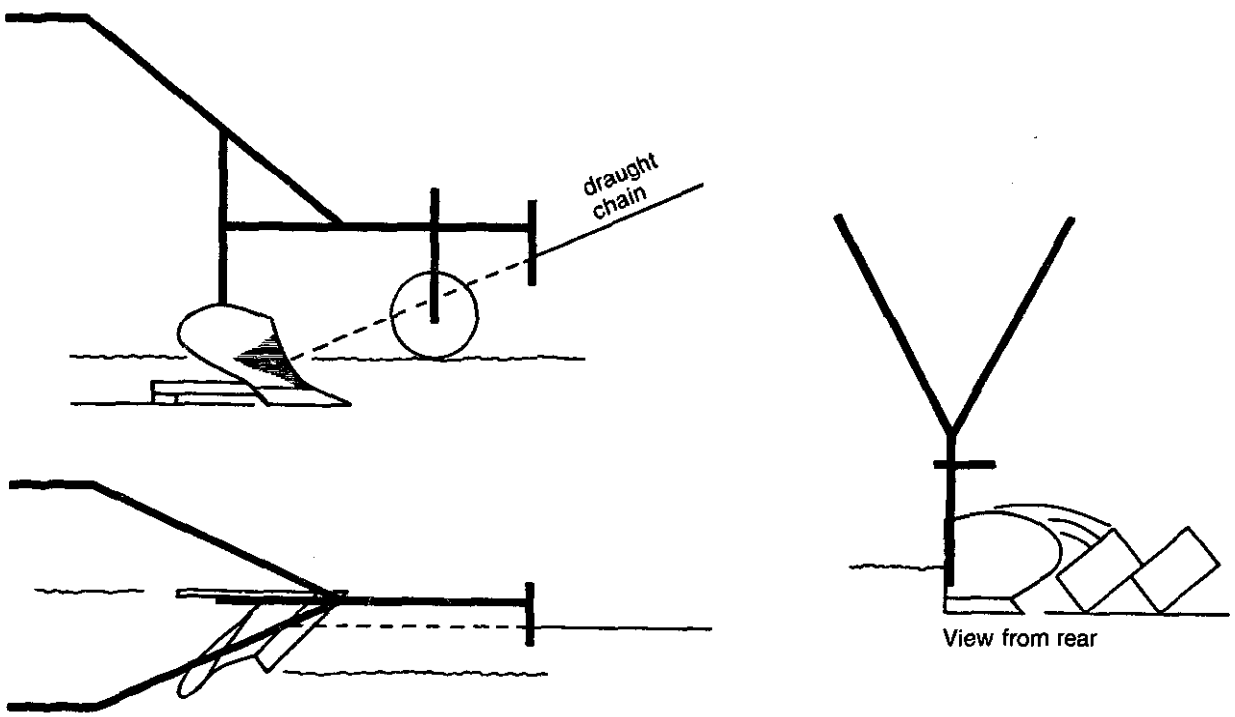

Fig.1 Three views of a mouldboard plough at its correct setting.

Steel implements for primary tillage Only rarely are steel ploughs and cultivators made in rural villages and, when they are, inferior materials cause them to be weak and inefficient. Such implements therefore are normally constructed in a factory where materials and processes can be controlled.

Mouldboard ploughs are designed to invert soil so as to aerate it and to bury weeds. Many of the single-purpose ploughs are based on original European designs with a heavy I-section curved beam, but some are of modern design to suit modern but simple manufacturing methods. There is a range of furrow widths to suit the animals available: 150mm wide shares for donkeys and small oxen worked singly, and up to 360mm for multiple spans of oxen or heavy horses. For tropical agriculture, semi-digger bodies are normally used, but some European suppliers offer Ley bodies for ploughing grassland.

Plough bodies normally comprise three components which are in contact with the soil:

i. 'share' which cuts the soil and roots and governs the furrow width,
ii. 'mouldboard' to invert the soil,
iii. 'landside' which stabilizes the unit against the unploughed land.

All three components are replaceable although the share wears most rapidly. The landside is sometimes fitted with a detachable 'heel' which avoids replacing the complete item. A shaped inner member or 'frog' is used to assemble the components, and square-shanked countersunk plough bolts and nuts are used. The 'frog' is in turn attached to the plough beam.

A gauge wheel or a skid is often fitted to restrict the depth of cultivation. Some ploughs have knife coulters to cut the soil surface above the leading point of the share, but these are only normally necessary for ploughing grassland. 'Reversible' ploughs are fitted with two plough bodies to turn soil alternately to the right or left, so as to progress from one side of a field to the other. This reduces the operation time and leaves a level field. Single mouldboard ploughs have to be used 'round-and-round' and the first furrows form a shallow ridge which is sometimes undesirable and has to be levelled. However, the increased field efficiency of reversible ploughs shortens the periods when the work-load is relieved at the end of the furrow and can lead to earlier animal fatigue.

Most modern animal-drawn equipment is pulled by a chain, which is attached to a hake at the front of the beam. The hake is an extension of the beam which allows the hitch point to be moved up, down or sideways. Implements should be set so they work at an even depth across the full width of the soil-cutting parts. Depth can be increased by raising the hitch point, but penetration can be poor if the soil is too hard and implements may tend to work at an angle, tilted forward. The hitch should

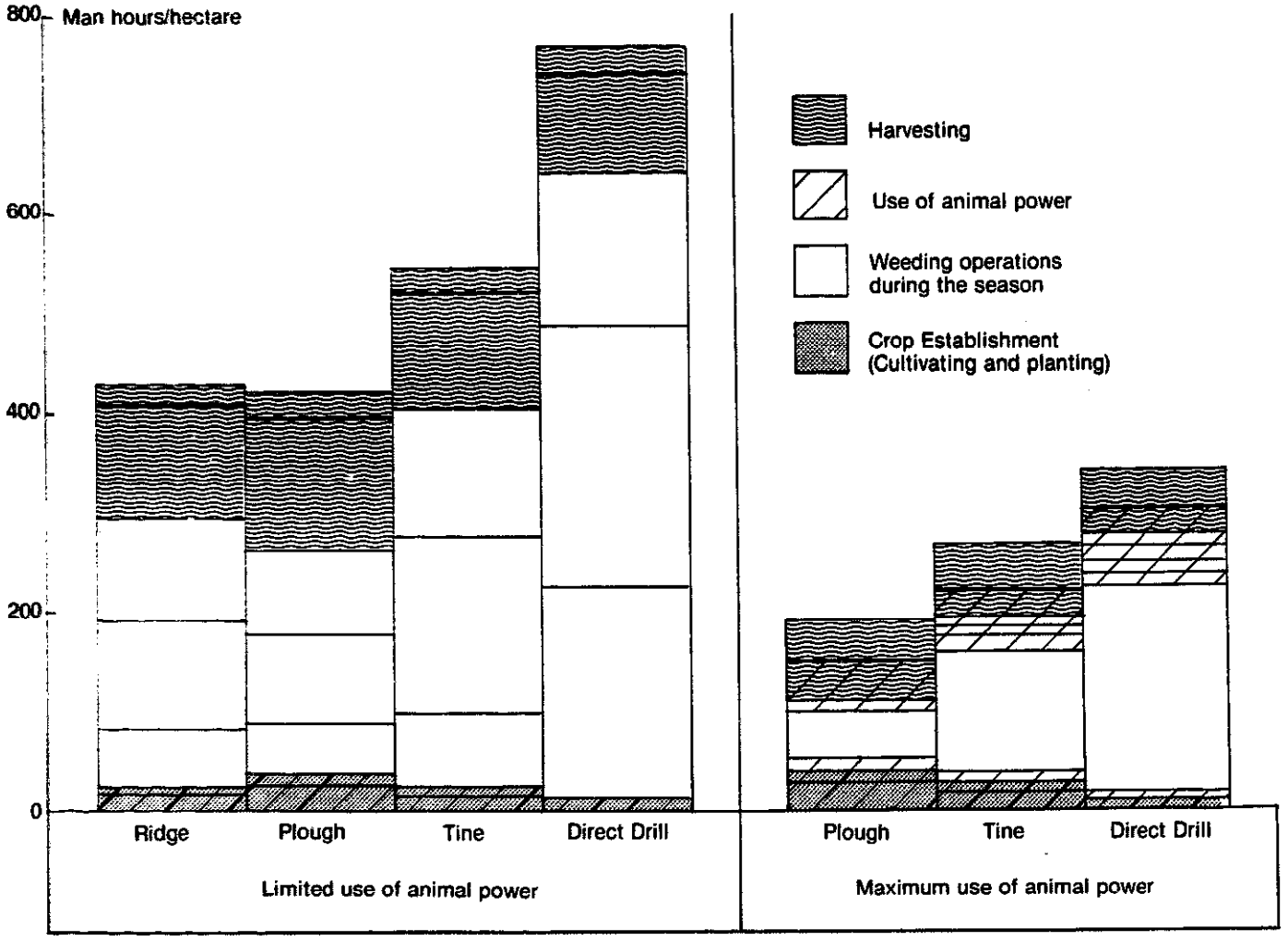

Fig.2 Seasonal labour input for the production of groundnuts (Matthews M.D.P. & Pullen D.W.M., 'Cultivation trials with ox-drawn equipment in The Gambia 1973-5', *The Agricultural Engineer*, Autumn 1977).

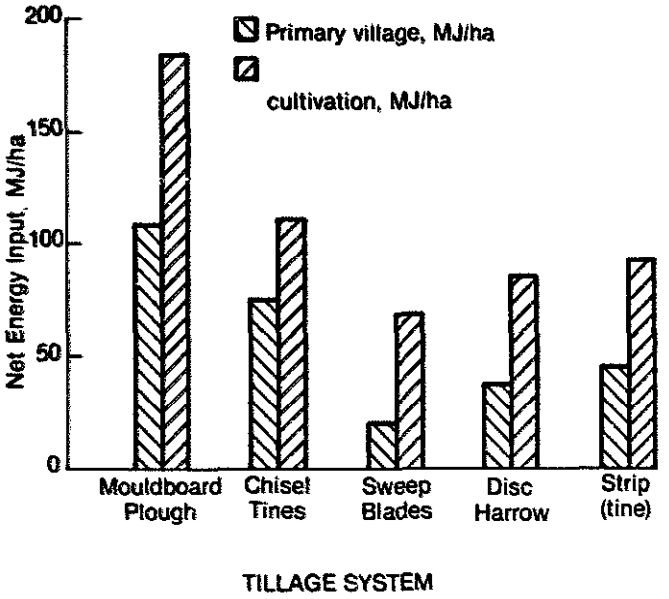

Fig.3 Tillage net energy inputs per ha under semi-arid conditions (Willcocks, T.J., 'Tillage of clod-forming sandy loam soils in the semi-arid climate of Botswana'. *Soil & Tillage Research* 1 (1980-81) pp.323-350 (Elsevier).

then be lowered so that the implement is level while operating (see Figure 1). Normally, only the mouldboard plough requires a side-hake adjustment. This allows the line of draught to point at the centre of load, which is usually low on the mouldboard just above the centre point of the share. Sideways adjustment swings the beam, thereby modifying the width of cut. If the plough is properly adjusted it should point straight ahead and require only light support from the operator. Extreme wear of the earth-contacting parts and the depth of the wheel/skid, results from poor adjustment, and the operator has to work unnecessarily hard. Once the basic principles of implement adjustment are appreciated, operators easily learn the amount of adjustment by field experience.

Other steel implements normally associated with secondary tillage can be used for primary tillage if the conditions are suitable. For instance, in The Gambia, the sandy loams can be ridged without previous tillage, once rain has softened the topsoil. This is an extremely quick method of crop establishment, but the labour demand during the growing season for weed control is immense, because there is no completely satisfactory method for weeding ridge-grown crops. Re-ridging is only partially successful in killing weeds, and substantial hand work is required. Figure 2 shows the labour requirement following different primary tillage techniques, also the reduction in labour required when a satisfactory system of mechanized weed control was introduced. In a very restricted cultivation/planting season, with a high incidence of weeds, the area managed per worker could be maximized by changing the crop establishment technique through the season as the weeds become harder to control. As the season progressed the methods used were:

i. Direct drill: conducted after the first rains, before weeds germinate, but needing substantial in-season weeding.
ii. Tine tillage: suitable for control of low, early season weed growth and needing some in-season weeding.
iii. Plough: slow but necessary once weed is established, giving good weed control well into the growing season.

This system was found to be particularly suitable for the production of groundnuts, although cotton benefited from thorough ploughing.

Steel sweeps, 300/500mm wide, can be used for shallow primary tillage. They provide good weed control where deep tillage or soil inversion is unnecessary or undesirable. Such a system is mainly applicable to light soils in semi-arid areas. An alternative system for semi-arid regions is to cultivate a narrow strip with a single tine into which a row crop is sown so that the majority of the soil is left undisturbed until weed control is necessary later in the season.

Disc harrows can also be used provided penetration is not a problem, and Figure 3 compares the alternative system in terms of energy input per hectare.

Secondary tillage This is the formation of tilth in preparation for planting and inter-row weed control. It is necessary to place seeds at a specified depth in contact with a fine tilth and to cover them. A cloddy soil will lead to poor germination, but too fine a surface could allow soil capping between infrequent showers, leading to poor emergence.

Small seeds need a finer seed-bed and are often broadcast which does not allow subsequent mechanized weed control. Larger seeds are more easily planted in rows and the labour for weed control during the season is minimized.

Secondary tillage can be carried out with drag harrows (see Figure 4), tines, or disc harrows. The drag harrows have a steel or wooden frame fitted with steel pegs, and weight can be added to the frame to aid penetration. Disc harrows are often fitted with a seat for the operator, whose weight automatically assists penetration. However, discs are generally more expensive than other forms of secondary tillage equipment.

Fig.4 Secondary cultivation with a drag harrow.

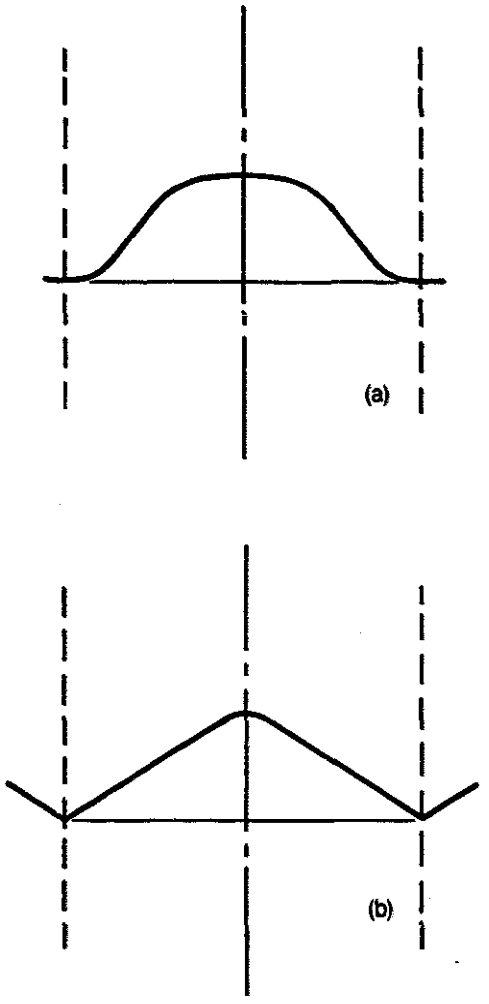

Fig.5 The cross-section of soil ridges.

Rigid or spring tines can be used in threes or fives for secondary cultivation. Although the speed at which oxen can cultivate is too low for spring tines to achieve soil shatter, their use does provide protection when obstacles are struck: the whole draught capacity can be imposed on a single tine when an obstacle is struck, so that the tine and its attachment to the frame have to be capable of withstanding it. For cultivation, tines are normally fitted with reversible points, approximately 50mm wide. Weeding requires a wider blade which can operate at shallow depths, and can cut roots. The blades, called duck-foot, or A-blades, need to overlap 25-30mm with neighbouring blades, so that the full operating width is covered.

The underframe clearance is an important factor to prevent the equipment riding out in cloddy soil or blocking with weed. Where such conditions are expected, 0.3 metres, measured from the point of the tine to the underside of the frame, is normally adequate.

Land forming Control and efficient utilization of water are a basic requirement of both rain-fed and irrigated agriculture.

On land with a slope in excess of 5 per cent, heavy tropical storms can cause soil erosion, and in severe cases fields can be totally degraded in 3-4 years. Conventional cultivation should be avoided on slopes over 12 per cent.

Below 12 per cent, ridgers can provide satisfactory water and soil conservation. The ridges should be aligned close to the contours, and an incline of 0.5 - 2 per cent provides adequate drainage. Where storms are heavy but infrequent the ridges can be tied, i.e. joined by a cross ridge at intervals of 2-3 metres, to hold back water in the furrow. The proper alignment of ridges is essential, because low points in a furrow can flood and break out from the side of the ridge, and this is then repeated down the slope.

Single-purpose ridgers sometimes incorporate the same frames as mouldboard ploughs. They are often constructed in a similar manner, with a leading share and twin mouldboards, although some have a breast-plate between the share and the mouldboard. Because the soil load on both sides of the implement is balanced, there is no need for a landside, although some ridgers are fitted with a fin which runs in the furrow bottom and provides directional stability. The shape of the ridge formed depends on the design of the ridging body, and Figure 5 shows the two extremes: (a) being that produced by a heavy-duty body with curved mouldboards, and (b) from a lightweight body with straight mouldboards.

The production of crops on ridges is also often recommended where soil erosion is not a problem. Their use can be justified in areas which become waterlogged, so that the plants are above the water inundation level and as such are suitable for flood irrigation; but where these conditions do not exist, cropping on the flat is normally preferable because weed control is easier.

Land planes and bund formers are necessary mostly in rice production where small fields are levelled so that water inundation is even. Bund formers are used to create temporary field boundaries between levels. These either disintegrate or are destroyed during harvesting or recultivation.

Earth scoops can be used for the construction of larger permanent bunds and for water storage facilities such as ponds and earth dams (Figure 6). Oxen can be used for pond or dam construction at 1/10th of the cost of contracted heavy powered machinery, and 1/7th of that of manual labour (Source: International Livestock Centre for Africa, Ethiopia). Scoops and planes can also be used for the construction of hillside terraces where the necessary expertise is available.

The maintenance required for simple tillage implements is minimal. Bolts and nuts should be kept tight; oil applied to threads will ease the removal of nuts when replacing parts. Greasing soil-contacting parts

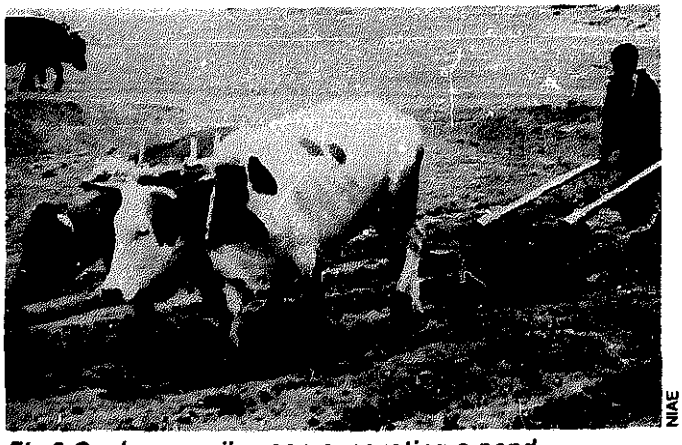

Fig.6 Ox-drawn soil scoop excavating a pond.

after work minimizes corrosion; the draught of a rusty plough is much higher than for a shiny one.

Motorized Cultivation

For rain-fed crop production, motorized cultivators can be an asset to small farmers in areas where high value crops are being grown and where fuel and service can be guaranteed. They are manufactured as two main types:

- Single-axis, driving a rotavator without land wheels. For very light duties traction wheels can be fitted instead of the rotor, to pull draught implements.
- Double axle, one driving traction wheels and one driving a rotavator. Being heavier and more powerful than the single-axle type the rotor can be removed and draught implements operated more effectively. Reversible mouldboard ploughs are often fitted to maximize field efficiency.

In dryland conditions where rotary cultivators cannot provide adequate traction for primary tillage, operators are tempted to use progressive passes, which apart from being uncomfortable, is damaging to the machine, and the rate of wear on the rotor blades is very high. The soil structure can be damaged by being too finely tilled and it is left exposed to wind and water erosion.

Pedestrian-controlled machines have proved very successful in wet soil preparation for rice, and many specialist machines are available. They are powered by diesel engines often with water cooling, on high clearance chassis. All parts are sealed against water, and steering brakes assist handling in rice paddies. For this work cage wheels are fitted to help in the puddling process.

Some of the machines can be used as tractor units for towing small trailers.

Extension

For mechanization to succeed when using these low-powered methods, a strong mechanization extension system is necessary in support of agricultural and veterinary services. The role of mechanization advisers is as follows:

- to provide specialist service to general agricultural extension agents;
- to assist with training for extension agents and farmers;
- to monitor the effectiveness of commercial and other lines of equipment supply;
- to encourage the involvement of the manufacturing and supply sector in the development of mechanization;
- to advise on items which qualify for credit and/or subsidies;
- to identify and encourage research programmes to benefit smallholder farmers.

The proper support of any level of mechanization involves far more than simply the delivery of new implements to market outlets to coincide with the soil preparation or trading seasons. Items inevitably wear, and under extreme conditions will bend or break, and so a constant stock of spare parts should be available from the point where the equipment was purchased. Farmers cannot be expected to wait for special parts orders to be despatched from a remote manufacturer or trader during a critically short operational season. On the other hand, local traders can only be expected to stock adequate supplies of spare parts if there are many farmers in the district operating the *same make* of cultivator.

Advantages

As one progresses through the range of cultivation equipment — from hand hoes, through animal-drawn equipment to low-powered cultivators — certain benefits can be expected to accrue to the farmers to whom they are introduced. These include:

- avoiding labour bottlenecks at critical stages of crop production;
- improving crop establishment conditions;
- improving the timeliness of operations;
- introduction of multiple cropping in irrigated areas.

Alternatives

Although this section is concerned with tillage equipment, mention should be made of zero or minimum tillage techniques, since these offer the most rapid method of crop establishment. Weeds are controlled by herbicides or shallow cultivation which then form a mulch with crop residues from the previous season, through which seeds are planted. The mulch eventually breaks down and helps to maintain the soil's organic matter, so that the productive life of land can be extended without the need of a fallow period. Mulch on the surface of uncultivated soil also reduces the incidence of soil erosion.

Choosing your Equipment

Costs and Benefits The following table shows the relative indicative costs for some of the equipment presented in this section.

	Capital cost (units)
Hand hoe	1
Traditional plough	5
Mouldboard plough	35
5-tine cultivator	50
12-disc harrow	70
Simple toolbar and attachments	85
Rotary cultivator	400

The cost of tillage is usually estimated in terms of cost per hectare cultivated. Costs incurred will include the cost of capital, depreciation, maintenance and repair, operator costs and cost of fuel (diesel or animal-feed). To calculate the cost per hectare, it will be necessary to know the work rates of the various devices. Indications of these are given in the table below.

Factors other than cost affect the choice of technology (from the individual's point of view). These include local traditions, current practices, field layouts, availability of credit, availability of government subsidies, prestige considerations, availability of grazing land, availability of veterinary services (particularly important where there is no tradition of animal traction or animal husbandry); materials and skills available for the production of draught animal harnesses; availability of fuel supplies, and availability of spare parts.

In addition, joint ownership of equipment or the provision of hire services may affect choice of technology. In theory this allows smallholder farmers to utilize more expensive equipment for heavy primary tillage while continuing the season with their own light equipment. Schemes whereby farmers contract/hire a

pair of animals and implements or a power tiller have proved more successful than hire schemes for 4-wheel tractors. So, such contract work sometimes has an adverse effect on timeliness of operations compared with farmers operating independently. This is heavily dependent on the management of the hire organization, but the distance between fields and the overall area being covered from one hire centre are also important.

The operation of power tillers within a specific irrigated rice scheme is likely to be the most efficient arrangement for both management and farmers. Assuming a reasonable level of utilization, the costs involved are likely to be in the following proportion:

	%
Capital costs (depreciation interest)	34.0
Fuel and lubricants	27.5
Repairs and maintenance	7.0
Labour and supervision	30.8
Storage	0.7

(Gill G.J., *Farm Power in Bangladesh*, University of Reading, 1981.)

Range of work rates for low-powered tillage systems

Method	*Soil type*	*Work rate h/ha*
Hand hoe	Clay	200-500
	Sand/sand loam	75-125
Traditional plough	Clay/clay loam	62-161
	Sand/sand loam	13-40
Mouldboard plough	Clay/clay loam	32-87
	Sand/sand loam	10-23
Spring tines (3) Ridger	Clay/clay loam	31-104
Disc harrow (approx.)	Sand/sand loam	9-13
Drag harrow	—	4-8
Power tiller 8-13 kW (6-10 hp)		
Ploughing	Clay/clay loam	8-12
Rotavating/puddling	Clay/clay loam	6-7

Impact

While the use of power tillers may increase returns to individual farmers, they can lead to displacement of labour (usually the poorest members of society) with resultant loss of much-needed income. Animal-drawn equipment can displace labour too, although not to such a great extent as the power tiller. While individual farmers may choose power tillers because of their apparent profitability, the social costs may, therefore, be substantial in terms of lost employment and income. Farmers may be able to grow more food with the aid of a power tiller, but this will be to little avail if, at the same time, it destroys the jobs, and thus the income needed to buy the extra surplus grown.

The introduction of power tillers may not necessarily destroy work places. Under the right circumstances, it may even result in expanded job opportunities through helping to overcome constraints on double or triple cropping, or by enabling higher yields to be achieved. In this case, many of the new work opportunities will be in weeding, seeding, harvesting and post-harvest activities — many of which are done by women. Improved technologies may need to be introduced for these activities too, so that women can cope with the increased workload.

While most hand tools and animal-drawn equipment can be made in rural towns, power tillers and their spare parts have to be imported in many Third World countries. Thus, the use of power tillers increases demands on scarce foreign exchange resources — a problem compounded by the need to import liquid fuel to run them.

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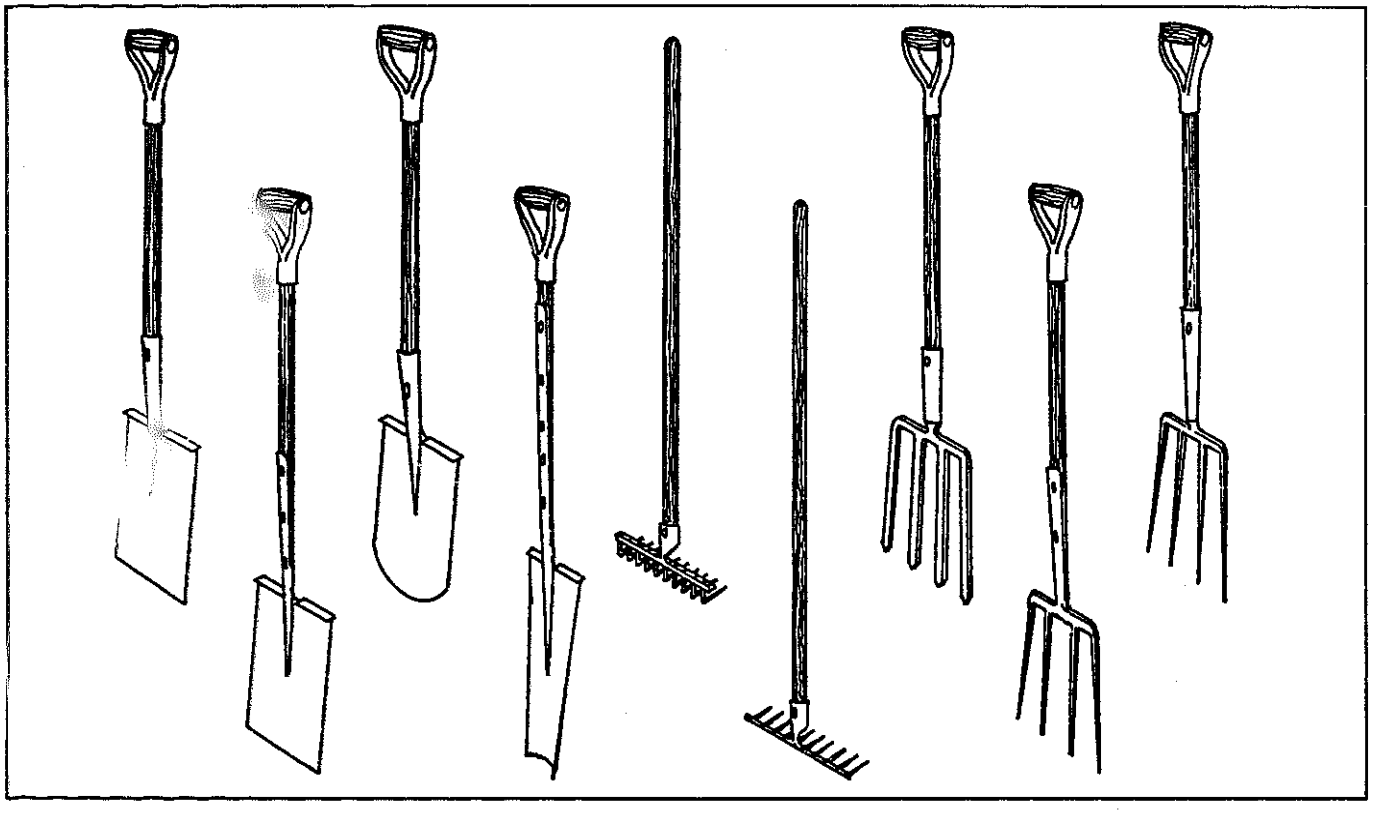
SPADES, FORKS AND RAKES



From left: solid socket treaded spade; strapped treaded spade; open socket treaded round nose spade; strapped treaded drainage spade; shaped-tine rake; garden rake; tang and ferrule broad-tine digging fork; strapped fork; solid socket digging fork.

Spades are tools which are used for digging and turning soil. Unlike shovels, which are essentially materials-handling implements, spades will be subjected to considerable strain when being used for land preparation work such as digging. This is reflected in their structure. The head of a spade will be made of a thicker and more tensile metal than would be found in a shovel head, and will have a slightly dished cross-section. The socket, where the head joins the shaft, will reflect a need to resist the high bending forces generated during soil turning and digging.

Forks used for seed-bed preparation may be divided into two groups according to prong shape and cross-section. A spade-fork (also called digging fork) is a heavy-duty implement with spatulated prongs used in a similar way and for similar functions as a spade. Ordinary digging or garden forks are distinguished by slender prongs which can be circular, triangular or square in section, although they are no less robust than the spade-fork. Their functions may include both primary (soil turning) or secondary (clod breaking) tillage operations.

Rakes are the hand-tool equivalent of the harrow and are used for secondary tillage of the seed-bed once it has been prepared with spades, hoes or forks. They are more lightly made than spades and forks, and are most often equipped with either an open socket or tang-and-ferrule attachment to the shaft. Rakes may be used for a variety of tasks including clod breaking, bed levelling and stone removal.

The table opposite lists a selection of spade, fork and rake manufacturers. An explanation of the table is as follows:

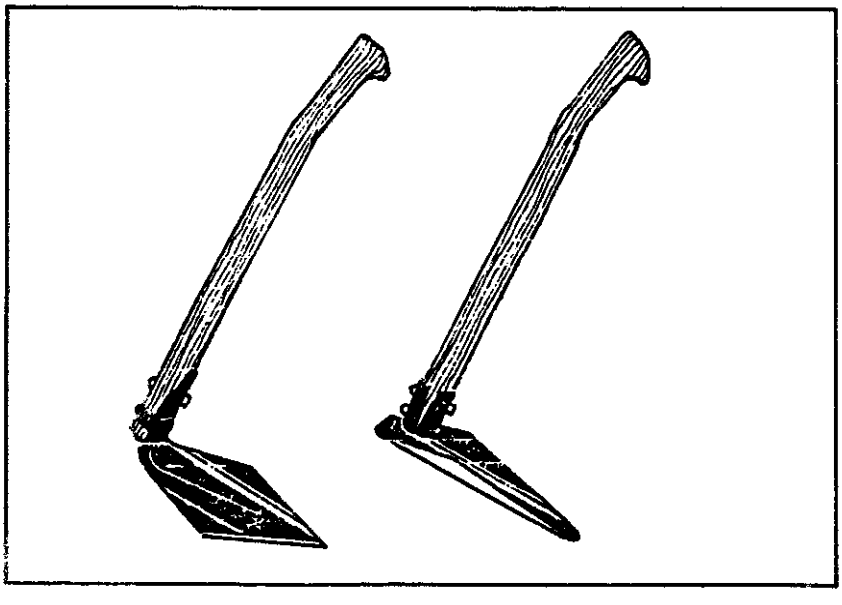
Col. 1: Manufacturer's name and country.
Col. 2: Description of item.
Col. 3: Referring to Figure 1, gives type of socket attachment where: solid = a socket which forms an unbroken collar into which the shaft is placed; t & f = tang and ferrule, in which the shaft is placed onto the pointed tang and secured by the ferrule — a collar of steel; open = a split cylindrical collar into which the shaft is fitted secured by one or more screws, nails or rivets; and strap = a socket formed from two tapered ferrule straps into which the shaft is fitted.
Col. 4: Implement head width (cm).
Col. 5: Implement head length (cm).
Col. 6: Gives further relevant information. In the case of rakes, the number of tines; for spades, whether or not the head is treaded; for forks, the prong cross-sectional shape where: TR = triangular; E = eliptical; C = circular; S = square or diamond.
Col. 7: Indicates the handle types available for each model, (see Figure 2) where: S = straight handle; T = T-shaped top to handle; D = D-shaped top to the handle in which the shaft is split and shaped and held apart by a cross-piece. Rivets are used to strengthen this type of handle. Sometimes purpose-made metal or plastic D-shaped grips are used; Y = a less well shaped split shaft with cross-piece handle.
Col. 8: Lists the number of implements produced that are similar to the one described. Further details about the design of hand tools can be found in the introduction in Section 9 on Materials Handling manure forks.

SPADES, FORKS AND RAKES

Manufacturer	Item	Socket Type	Head Width	Head Length	Other Features	Handle Type	No. of Models
BORAL CYCLONE AUSTRALIA	Nailrake	solid	154.0		16 tine	S	5
	Digging fork	t&f	16.5	27.0	C	D	6
	Digging fork	t&f	18.5	30.0	C	S	
	Heavy duty spade	solid	19.0	30.0	tread	D	7
	Garden spade	solid	19.0	30	tread	S	
BULLDOG TOOLS U.K.	Digging spade	solid			tread	Y/T	13
	All metal spade				tread	D	
	Digging fork	solid				Y/T	6
	Turning fork	strap				Y/T	
	Tang & ferrule rake	t&f			11 tine	S	3
BURGON AND BALL U.K.	Digging spade	solid	19.0	29.0		T/D	6
	Medium spade	solid	16.5	25.5		T/D	
	Digging fork	solid	19.5	32.0	E	T/D	6
	Medium fork	solid	16.5	28.0	C	T/D	
	Lawn rake	open			16 tine	S	2
CALDWELLS U.K.	Treaded spade	strap	19.0	29.0	3-rivet	Y	11
	Export spade	strap	21.5	31.0	3-rivet	D	
	Digging fork (3-rivet)	strap	20.0	31.0	S	T	5
	Trenching fork (5-rivet)	strap	20.0	32.0	S	D	
	Garden rake	t&f			12 tine	S	2
COSMO INCORPORATED JAPAN	Square spade	solid	18.0	30.0		Y	3
	Garden spade	solid	13.0	25.0		S	1
	Spading fork		19.0	30.0	E	D	1
	Bow rake	open			16 tine	S	2
	Garden rake	open			14 tine	S	2
ELKEM NORWAY	Ditching spade	solid	21.0	36.0	tread	D	6
	Garden spade	solid	19.0	30.0	tread	D	
	Spade fork	solid	19 5	30.0	E	D	2
	Hoeing rake	solid	26.0	8.5	10 tine	S	5
	Road Rake	solid	37.0	9.5	14 tine	S	1
FERFOR PORTUGAL	Garden spade	solid	19.0	28.0	tread	D	1
	Spading fork	solid		25.0	E	D	1
	Straight tooth rake	solid	32.5	7.5	14 tine	S	1
FISKARS FINLAND	Digging fork	strap	17.5	30.0	TR	D	2
	Round nose spade	solid	21.5	37.0	tread	D	3
FORGES DE LAVIEU FRANCE	Digging fork	strap		30.0	S	T/D/S	3
	Digging fork	strap		27.0	E	T/D/S	2
	Digging fork	solid		30.0	TR	T/D/S	9
	Digging fork	strap		30.0	TR	T/D/S	
	Garden rake	solid			14 tine	S	3
HERRAGRO COLOMBIA	Spade-Santanda	open	21.0	38.0		—	
	Spade — Hoyadora	solid	18.0	30.0	tread	—	
	Spade — Narino	solid	17.5	37.0		—	
IDEALSPATEN & SCHAUFELWALZWERK W. GERMANY	Builders spade	strap	18.5	28.5	tread	T/D/S	47
	Bremer spade	strap	21.0	27.0		T/D/S	
	Drainage spade	strap	15.0	45	tread	T	
	Sand spade	strap	17.5	28.5		T	
	'Record' spade	strap	18.5	28.5	tread	T/S	
KUMAR INDUSTRIES INDIA	Digging fork	strap		33.0	S	T/D	
	Digging fork	strap		38.0	S	D/T	
	Digging fork	strap		45.7	S	D/T	
LÉON CLÉMENT FRANCE	Digging fork	t&f		27.0	E	S/T/D	
	Digging fork	open		30.0	E	S/T/D	
	Round nose spade	solid	30.0	30.0		—	
	Square mouth spade	solid	25.0	29.0		—	
LYSBRO FABRIKER DENMARK	Digging spade	solid	18.0	27.0	tread	D	10
	Forest spade	strap	22.0	36.0		D	
	Digging fork	solid	20.5	30.0	S	D	8
	Marl fork	strap	25.0	35.0	S	D/S	
	Garden rake	solid	35.0		14 tine	S	8
MANUFACTURE FRANÇAISE DES FOURCHES FRANCE	Digging fork	strap		30.0	E	S/T/D	13
	Digging fork	open		27.0	E	S/T/D	
	Turning rake	open			14 tine	S	5
	Standard spade	solid			tread	S/T/D	4
	Tapered spade	solid				S/T/D	
NORBERGS SPAD-& REDSKAPSFABRIKER SWEDEN	Trenching spade	strap	21.0	36.0	tread	Y	4
	Garden spade	strap	18.0	26.0	tread	D/T	8
	Spade fork	strap	19.0	30.0	E	T	2
	Garden fork	strap	15.0	23.0	TR	D	2
	Garden rake	solid	35.0		14 tine	S	10

Manufacturer and address	Item	Socket Type	Head Width	Head Length	Other Features	Handle Type	No. of Modes
POLAR WERKE W. GERMANY	Heavy garden spade	solid	18.5	28.5		S/T	
	Small garden spade	solid	15.5	18.0		S/T	
	Toothed spade	solid	16.5	25.0		T	
	Spade fork	solid	18.0	23.0		T	
	Steel rake	open	31.0		12 tine	S	11
SICFO FRANCE	Digging fork	strap		27.0	TR	S/T/D	3
	Digging fork	solid		27.0	E	S/T/D	3
	Trenching spade	solid		28.0		S	2
	Square mouth spade	solid				S	1
	Rakes	open			16 tine	S	14
SPEAR & JACKSON (TOOLS) U.K.	Digging fork	solid	20.0	32.0		Y/T	4
	Medium fork	solid	17.0	28.0		Y/T	2
	Digging spade	solid	19.0	29.0	tread	Y/T	12
	Irish spade	strap	16.5	33.0	tread	T	
	Garden rake	t&f			12 tine	S	5
TRAMONTINA SA BRAZIL	Rake	solid	31.6	8.5	12 tine	—	4
	Square spade	solid	23.0	27.0		—	2
	Round point spade	solid	21.0	27.0		—	2
	Digger	solid	8.7	22.0		—	2
TROJAN AUSTRALIA	Digging fork	t&f	21.0	31.0	S	D	
	Digger fork	solid	16.5	28.5	E	D	1
	Steel bow rake	open			14 tine	S	5
	Digging spade	solid	19.0	30.5		D	6
	Spademaster	solid	19.0	30.0	tread	D	5
TROPIC CAMEROON	Square mouth spade	solid				S	2
	Round mouth spade	solid				S	3
	Digger	solid				—	1
	Rake	open			12 tine	—	1
WILHELM ABT W. GERMANY	Spade fork	strap	20.0	28.0	C	S/D/T	3
	Digging fork	strap	21.0	30.0	S	T/D	1
	Turning rake	open	70.0		20 tine	S	5
	Drawing rake	open	12.0	25.0	28 tine	S	4
WÜRTT GABELFABRIK W. GERMANY	Garden fork	strap			C	S	5
	Spade fork	strap			C	S/T/D	
	Sweep rake	open			32 tine	S	9

FORESTRY PLANTING HOES

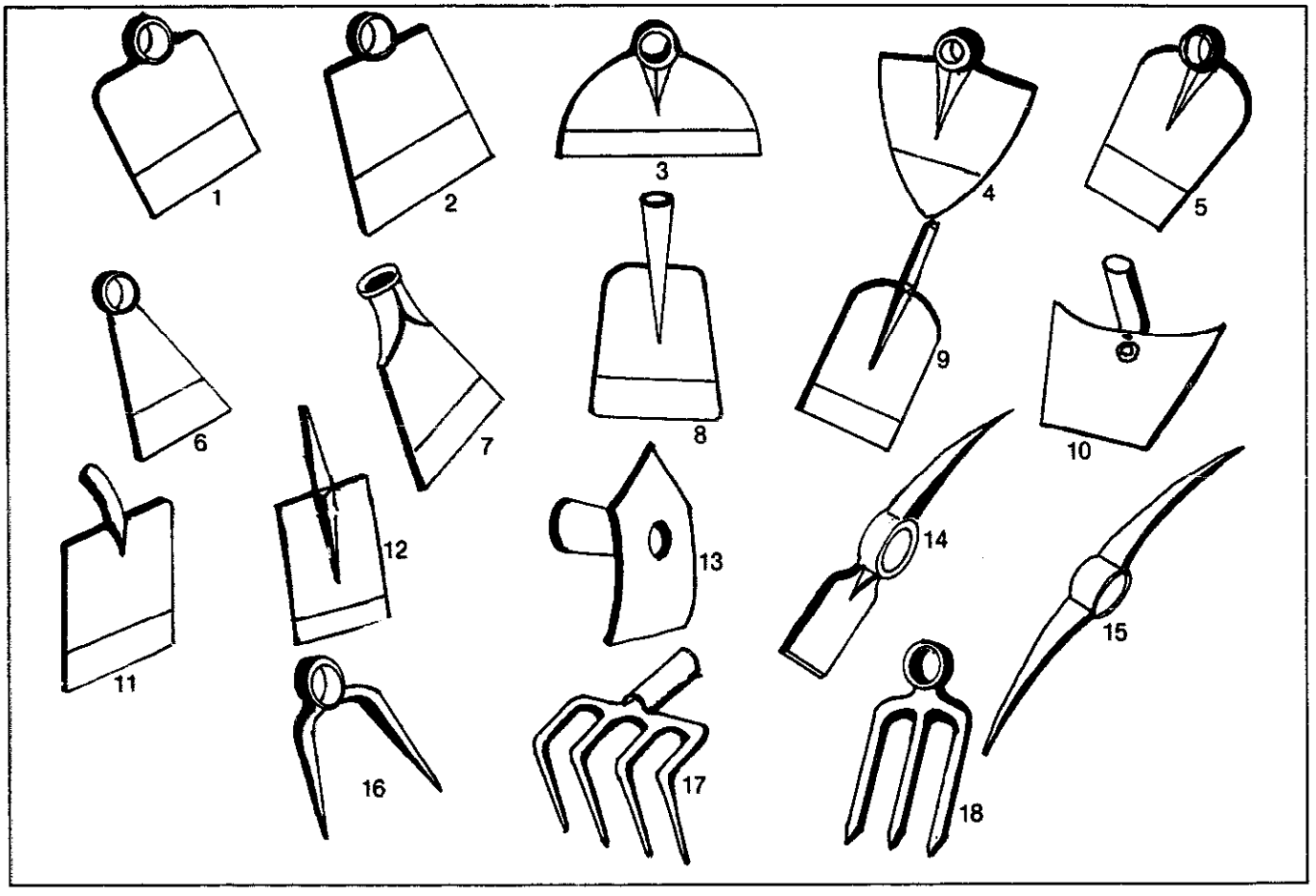


Forestry Planting Hoes

Whilst the table on the next page gives information about general agricultural hoes, specialist hoes are now available for certain purposes, such as the two forestry planting hoes illustrated left. On the left is a 1.5 kg, 210 mm blade, 830 mm handle planting hoe. On the right is a 0.9 kg, 140 mm blade, 550 mm handle small planting hoe. Both blade and handle are precision made using ergonomic criteria. They are available from:

FISKARS
Mannerheimintie 14 A, PO Box 235
SF-00101 Helsinki 10
FINLAND

HOES



Hoes are probably the most widely used tillage implement in the world. The range of forms that have been evolved in different regions (of which a limited sample is illustrated above), reflects both varying local conditions such as soil and climate, and the specific needs of a people engaged in the cultivation of a certain crop or crops.

The hoes shown here are essentially primary tillage implements and are designed mainly for soil digging work. However, hoes are used for many other purposes, particularly weeding, ridging, bund forming and so on. They are the essential primary tool of hoe farming cultures in which they are used for most farming operations. Initially they may be used to clear land of large weeds, in a scything action; to turn the soil over to bury the smaller weeds; to knock down the clods of earth to form a seedbed; or to mound up the soil into planting hills; to open the soil to plant (particularly) large vegetative material e.g. cassava; to weed; to mound up or ridge; to make irrigation bunds and channels and to divert irrigation water onto plots. The hoes in the illustration above can be divided into three main categories:

(a) Digging hoes which are used with a double-handed chopping action. These include the ring socket blade hoes (1-6), hoes with straight open or solid sockets (7, 8, 10, 11, 13) and hoes with a tang onto which the shaft is fitted (9, 12).
(b) Mattocks and pickaxes (14, 15) which are useful for heavy-duty work on hard or unbroken ground.
(c) Tined hoes (16, 17, 18) which have a similar function to forks.

The table on the next page lists a selection of manufacturers and indicates the range of hoes available from each.

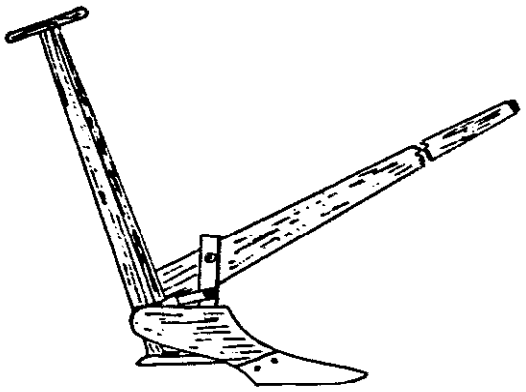
There are so many varied designs of hoe that the classification used is necessarily approximate. Hoes appropriate to local conditions are usually available in local markets. Of the manufacturers which sent information it would seem that, among others, the following have the fullest range of hoes for export: Chillington, Edelmiro Vasquez, Ferfor, Herragro, Schwäbische Hüttenwerke, Tramontina and Villhard.

s of hoes,

Country																		
Brazil	●	●	●											●	●			
Malawi									●									
Australia	●		●											●	●			
U.K.														●	●			
U.K.	●													●	●			●
Cameroun		●					●											●
U.K.	●	●	●	●	●				●			●				●		●
Italy	●													●	●	●		●
Japan	●					●								●	●		●	●
Spain	●	●	●	●	●	●								●	●	●		
India	●									●								
Norway													●	●	●			
Portugal	●	●	●		●	●			●					●	●		●	●
France	●	●															●	●
Argentina	●		●											●	●			
U.K.														●	●			
India	●												●					
Colombia	●	●	●			●	●	●						●	●			
Kenya	●																	
W. Germany														●	●			
El Salvador	●	●					●							●	●			
U.K.														●	●			
Pakistan	●					●												●
Korea														●	●			
India														●	●			●
India	●	●				●						●		●	●			●
France	●																	●
France	●	●	●	●							●			●	●	●		●
India	●														●			
France	●																●	●
India			●			●												
W. Germany																	●	
India		●													●			
U.K.																	●	
W. Germany	●	●	●	●	●	●								●	●	●		●
USA	●	●	●												●			
USA	●		●			●												
France														●			●	
France						●									●		●	
Brazil	●		●			●	●							●	●			
Australia	●		●											●	●		●	
Cameroon	●						●								●			
W. Germany	●	●	●			●	●							●		●	●	●
W. Germany	●																●	●
W. Germany	●	●		●		●											●	●
Tanzania	●								●						●			
Zimbabwe	●								●									

Table of the manufacturers of hoes, picks and mattocks.

Manufacturer	*Country*																		
AÇOTUPY IND. MET.	Brazil	●	●	●											●	●			
AGRIMAL	Malawi									●									
BORAL CYCLONE	Australia	●		●											●	●			
BULLDOG TOOLS	U.K.														●	●			
CALDWELLS	U.K.	●													●	●			●
CENEEMA	Cameroun		●					●											●
CHILLINGTON TOOL CO.	U.K.	●	●	●	●	●				●			●				●		●
C.E.A.F	Italy	●													●	●	●		●
COSMO INCORPORATED	Japan	●					●								●	●		●	●
EDELMIRO VAZQUEZ Y HNO	Spain	●	●	●	●	●	●								●	●	●		
EICHER GOODEARTH	India	●									●								
ELKEM	Norway													●	●	●			
FERFOR	Portugal	●	●	●		●	●			●					●	●		●	●
FORGES DE LAVIEU	France	●	●															●	●
GHERARDI E HIJOS	Argentina	●		●											●	●			
GILPIN & CO.	U.K.														●	●			
GOVERNMENT IMPLEMENT FACTORY	India	●												●					
HERRAGRO	Colombia	●	●	●			●	●	●						●	●			
IDEAL CASEMENTS	Kenya	●																	
IDEALSPATEN	W. Germany														●	●			
IMACASA	El Salvador	●	●					●							●	●			
JOHN PERKS & SONS	U.K.														●	●			
KHAWRI & CO.	Pakistan	●					●												●
KOREA TRADE PROMOTION CORPORATION	Korea														●	●			
KUMAON NURSERY	India														●	●			●
KUMAR INDUSTRIES	India	●	●				●						●		●	●			●
LANG FERRY	France	●																	●
LÉON CLÉMENT	France	●	●	●	●							●			●	●	●		●
MAHARASHTRA AGRO IND. DEV. CORP.	India	●														●			
MANUFACTURE FRANÇAISE DE FOURCHES	France	●																●	●
MODERN ENGINEERING CO.	India			●			●											●	
POLAR WERKE	W. Germany																		
RAJAN UNIVERSAL EXPORTS	India		●													●			
SAMUEL PARKES & CO.	U.K.																	●	
SCHWÄBISCHE HÜTTENWERKE	W. Germany	●	●	●	●	●	●								●	●	●		●
SCOVIL HOE CO.	USA	●	●	●												●			
SEYMOUR MAN. CO.	USA	●		●			●												
SICFO	France														●			●	
SYNDICAT DE L'OUTILLAGE AGRICOLE ET HORTICOLE	France						●									●		●	
TRAMONTINA SA	Brazil	●		●			●	●							●	●			
TROJAN	Australia	●		●											●	●		●	
TROPIC	Cameroon	●						●								●			
VILLHARD & CO.	W. Germany	●	●	●			●	●							●		●	●	●
WILHELM ABT & CO.	W. Germany	●																●	●
WÜRTT. GABELFABRIK	W. Germany	●	●		●		●											●	●
ZANA ZA KILIMO	Tanzania	●								●						●			
ZIMPLOW	Zimbabwe	●								●									



TRADITIONAL VILLAGE PLOUGHS

These ploughs are designed for furrowing but do not invert the soil. They are light in weight and therefore easy to manoeuvre and carry.

PLOUGH MEP-45
A plough fitted with a wooden beam, handle and a steel share. It will cut a furrow 75 to 125mm deep and 125 to 170mm wide.

MODERN ENGINEERING COMPANY
1A Anna Street, Velandi Palayam
Coimbatore 641 025, Tamil Nadu
INDIA

BALWANT PLOUGH
It weighs 42kg and is made of wood and iron. Requires a pair of bullocks and cuts a furrow 20cms deep, 25cms wide.

NEW VIJAY INDUSTRIES LTD.
P.O. Willingdon College
Vishrambag, Sangli 416 415
Maharashtra, INDIA

A similar plough is produced by Union Forgings.

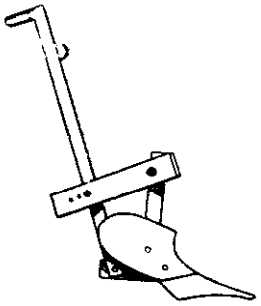
UNION FORGINGS
Focal Point, Sherpur
Ludhiana, Punjab, INDIA

MACO SOIL-STIRRING PLOUGH
This plough (illustrated) weighs 14kg and with one pair of bullocks can till up to one acre a day. The furrow produced is 11cm deep and 17cm wide.

MOHINDER & CO. ALLIED INDUSTRIES
Kurali, Distt. Ropar, Punjab, INDIA

LCS-111 STEEL-ANIMAL PLOUGH
A slightly different design having a curved steel beam, handle and hake.

LIM CHIENG SENG FACTORY
92-94 Sawanvithee Road
Nakom Sawan, THAILAND



SIMPLE BULLOCK-DRAWN MOULDBOARD PLOUGHS

These ploughs have a straight beam bolted to the handle and mouldboard support. (The mouldboard is designed to invert the soil to bury weeds.)

SUBHASH PLOUGH
A general-purpose, 150mm mouldboard plough made entirely of steel and weighing 11kg. The ploughing depth can be adjusted, and right- and left-hand mouldboard types are available. Up to 0.6 to 0.8 acres can be covered in a day.

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

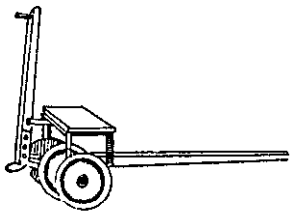
SOIL INVERTING PLOUGH
The plough weighs 15kg and with a pair of bullocks can plough up to one acre in a day. It cuts a furrow 11cm deep and 15cm wide.

MOHINDER & CO. ALLIED INDUSTRIES
Kurali, Distt. Ropar, Punjab
INDIA

Similar mouldboard ploughs are also available from Union Forgings and West Bengal (illustrated left).

UNION FORGINGS
Focal Point, Sherpur,
Ludhiana, Punjab
INDIA

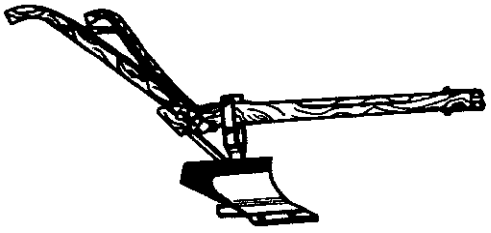
WEST BENGAL AGRO-INDUSTRIES CORPORATION LTD.
23B Netaji Subhas Road, 3rd Floor
Calcutta 700 001
INDIA



ANNAPURNA DISC PLOUGH

A bullock-drawn plough weighing 18kg. It covers a width of 55cm and can plough one acre in 4 to 5 hours.

ANNAPURNA TRANSPLANTERS
62 Suryanagar
Bhubaneswar 751003, Orissa
INDIA



MOULDBOARD PLOUGH WITHOUT COULTER

These ploughs have a straight beam with a hake at the front. The plough body is attached to the beam by means of a vertical bar.

AH5S TYPE H-5 MOULDBOARD PLOUGH WITHOUT COULTER
Made of wood and steel and designed to be drawn by one horse, this plough (illustrated) weighs 16kg and cuts a furrow 13cm deep and 25cm wide.

MARCHESAN IMPLEMENTOS E MÁQUINAS AGRÍCOLAS TATÚ S.A.
C.P. 131, 15.990 Matao SP
BRAZIL

MOULDBOARD PLOUGH
The draught assembly runs from the centre of the beam through an adjustable hake at the nose. Attachments for weeding and ridging are also available.

S.C.A.D. BOURGUIGNON
B.P. 17
26301 Bourg-de-Péage-Cédex
Drome
FRANCE

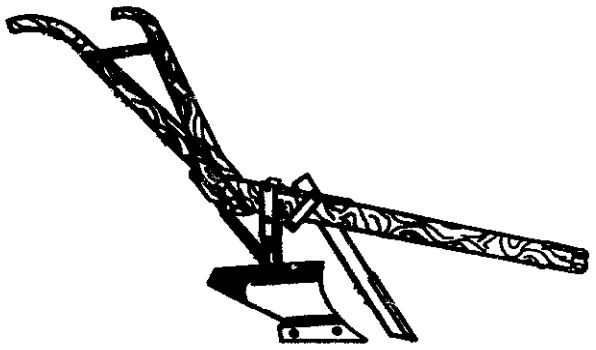
CARE PLOUGH
The body of this plough is made of cast-iron and the U-clamp, standard and share are all steel. It will cover 0.6 to 1.0 acres in a day. Two sizes are available weighing 14.5 and 10.5kg.

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

DONKEY-DRAWN PLOUGH

This plough weighs 13kg and is equipped with an adjustable land wheel. The mouldboard and ridger are interchangeable.

ETS. TÉCHINÉ
82400 Valence d'Agen (T & G)
FRANCE



MOULDBOARD PLOUGHS WITH COULTERS

These ploughs have an A-shape handle and a knife coulter for cutting roots and other obstacles.

AH5F TYPE H-5
Designed for one horse, this plough (illustrated) has a wooden frame and a steel mouldboard. It weighs 17kg and has a penetration of 13cm and cutting width 25cm.

MARCHESAN IMPLEMENTOS E MÁQUINAS AGRÍCOLAS TATÚ S.A.
C.P. 131, 15.990 Matão SP
BRAZIL

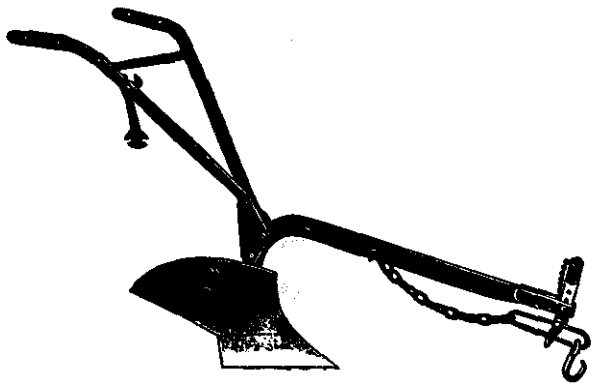
TYPE H-5
The walking mouldboard plough above is also produced by Baldan. The frame is available without mouldboard or coulter. Separate attachments can be supplied for cultivating, furrowing, ridging etc.

BALDAN IMPLEMENTOS AGRÍCOLAS S.A.
Av. Baldan 1500, C.P. 11
15.990 Matão S.P.
BRAZIL

A2G MOULDBOARD PLOUGH
Three sizes are available weighing 24,27 and 34kg, with working depths of between 15 and 18cm.

NARDI FRANCESCO & FIGLI
06017 Selci Lama, Perugia
ITALY

HEAVY DUTY PLOUGHS WITH COULTER
This larger type of plough is designed to be drawn by two animals.
The AH6F type H-6 is produced by Marchesan and Baldan. It has a working depth of 15cm and weighs 29kg. Two larger models are also available. Nardi produce a series of ploughs ranging from 26kg to 60kg in weight and with working depths of 15-38cm.



CURVED BEAM PLOUGHS

The ploughs described here are distinguished by a curved beam to which the plough-body and walking handles are attached. They are not equipped with a land wheel.

THE HSIAOKAN STEEL PLOUGH
Suited to light soils, both water-logged and dry, this adjustable plough consists of a beam, trapezoidal plough-body and plough tail. It is able to work to a depth of 150mm and gives furrow widths of up to 180mm. Its weight is 16.5kg, requiring a tractive force of 70-110kg.
Manufactured by Hsiaokan Steel Plow this model is available through:

CHINA NATIONAL AGRICULTURAL MACHINERY IMPORT AND EXPORT CORPORATION
26 South Yeutan Street, Beijing
CHINA
Other very similar ploughs are available from the following manufacturers:

CHOK CHAROEN
724/5 Kor Po-thong Road
A. Muang, Chonburi
THAILAND

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

AGRICOLA
34 rue Beni Amar
Casablanca
MOROCCO

S.C.A.D. BOURGUIGNON
B.P. 17
26301 Bourg-de-Péage-Cedex
Drome, FRANCE

SP 01 PLOUGH
A light-weight implement (15kg) giving a working width of 20cm and working depth of 15cm. Land wheel is optional.

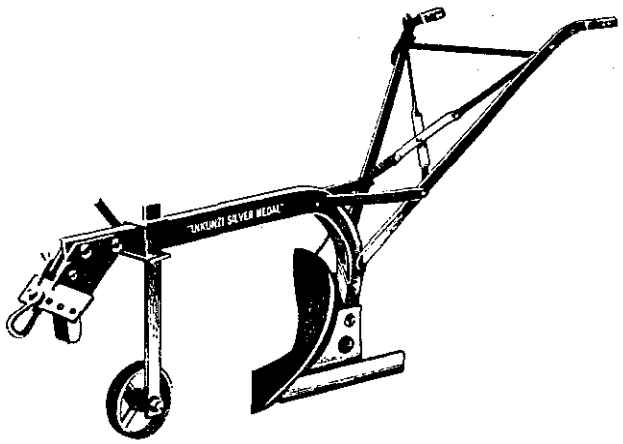
BAYERISCHE PFLUGFABRIK GmbH
Postfach 80
Von-Kühlmann-Straße 25
8910 Landsberg a. Lech
F. GERMANY

'PIORUN' PLOUGHS
Adjustable horse-drawn ploughs designed for medium to deep tillage on compact or semi-compact soils.

	U-057	U-058	U-059
Furrow width	24cm	26cm	28cm
Plough depth	19cm	21cm	25cm
Output/10h	0.6ha	0.7ha	0.8ha
Weight	24kg	29kg	31kg

Manufactured by Agromet-Unia these ploughs are available through:

AGROMET MOTOIMPORT
Foreign Trade Enterprise
P.O. Box 990, Warsaw
POLAND



CURVED BEAM PLOUGHS WITH LAND WHEEL

Equipped with an adjustable land wheel, these single furrow ploughs have a curved beam and draught coupling at the nose. An important feature of the ploughs is their fabrication from bolted-together components. This simplifies assembly and replacement of worn parts.

'IKUNZI' SILVER MEDAL PLOUGH
Developed to meet southern African conditions, the 'Ikunzi' plough (illustrated) is a heavy-duty implement constructed by bolted-together iron and steel components which facilitates assembly and maintenance.

BULAWAYO STEEL PRODUCTS
8 Ironbridge Road, Donnington
P.O. Box 1603, Bulawayo
ZIMBABWE

C.O. PLOUGH
This mouldboard plough has been developed and manufactured in Fiji. It is equipped with a fully adjustable land wheel and bracing rods between the curved beam and handles.

ELISHA ENGINEERING
38 Nabeka Street, P.O. Box 42, Ba
FIJI

RAM NARAYAN ENGINEERING
Koula Road, Residence: 74846
P.O. Box 271, BA
FIJI

Similar ploughs are also manufactured by:

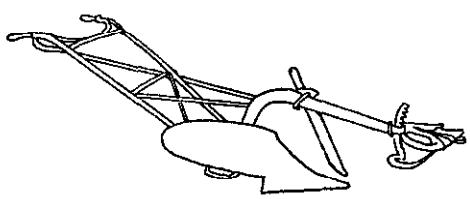
TROPIC
B.P. 706, Douala
CAMEROON

TAURUS SPRAYING SYSTEMS (PVT.) LTD.
20 Harrow Road, Msasa
Harare, P.O. Box AY 18, Amby
ZIMBABWE

JOHN HOLT AGRICULTURAL ENGINEERS LTD.
New Industrial Estate
P.O. Box 352, Zaria, Kaduna State
NIGERIA

ALVAN BLANCH DEV. CO. LTD.
Chelworth, Malmesbury
SN16 9SG, Wilts.
U.K.

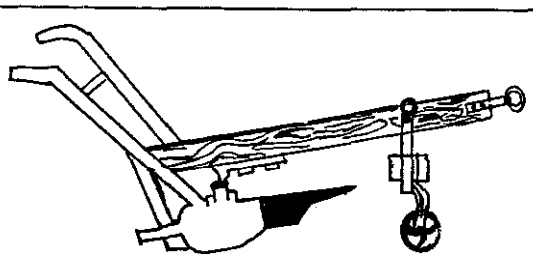
S.C.A.D. BOURGUIGNON
B.P. 17
26301 Bourg-de-Péage-Cédex
Drome
FRANCE



T.R. PLOUGHS

K.K. Lien of Norway produces 2 ranges of animal-drawn mouldboard ploughs distinguished by a long mouldboard and hanging coulter, and by the absence of a land wheel. The mouldboard and coulter are of soft-centred steel, while the beam and handles are made from steel of a harder temper.
The light-weight P-type walking ploughs are available in 4 sizes. The 36 and 49kg models are drawn by one animal while the 56 and 64kg models require the draught of 2 animals.
The more robust TR ploughs (illustrated) are suited to heavier conditions. The TR26 and TR28 (72 and 78kg) are drawn by 2 animals, while the TR31 (84kg) requires the draught of 3 animals.

K.K. LIEN FABRIKK A/S
Tromøy, Arendal
4812 Kongshamn
NORWAY

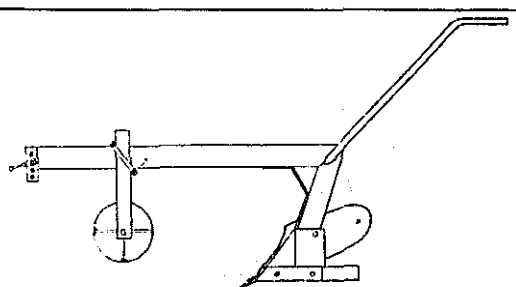


WOODEN BEAM PLOUGH

These ploughs consist of a straight wooden beam to which are attached an adjustable land wheel, plough body and handles. Draught linkage is at the nose of the beam.
The model produced by Modern Engineering (MBP-46) weighs 50kg and has a working width of 125-200mm.
A similar implement weighing 45kg is manufactured by Zana Za Kilimo (illustrated).

MODERN ENGINEERING COMPANY
1A Arms Street, Velandi Palayam
Coimbatore 641 025, Tamil Nadu
INDIA

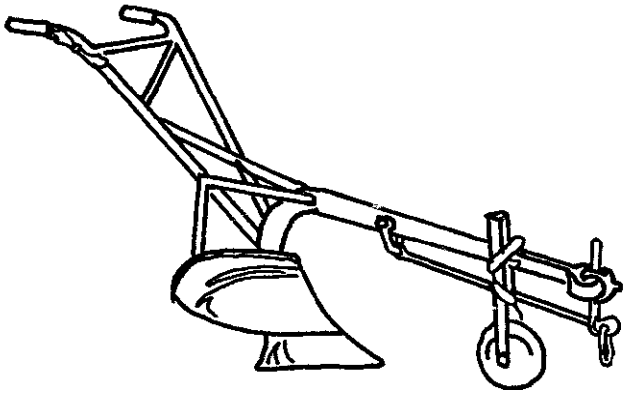
ZANA ZA KILIMO LTD.
P.O. Box 1186, Mbeya
TANZANIA



IMPROVED PLOUGH

The Lugari Extension Programme has used a standard manufactured implement as a basis for the introduction of a number of design changes. The major alterations have been made to the plough body, where the share has been strengthened and the landside extended to overcome stability problems. The beam has also been improved by welding 2 strips of flat iron to the sides of the I-section, and by introducing a toggle-bar adjustment mechanism to the land wheel.

LUGARI EXTENSION PROGRAM
Appropriate Implements Project
P.O. Box 125, Soy
KENYA



GENERAL PURPOSE PLOUGHS

The single-furrow, animal-drawn ploughs described here have the following characteristics in common:
- curved beam;
- adjustable land wheel;
- draw-bar assembly linkages located on the beam towards the handles and at the beam nose;
- cylindrical-helical mouldboard.

The plough illustrated above left is manufactured extensively throughout eastern and southern Africa. All components are bolted and can be easily removed with a spanner should the need for maintenance and part replacement arise. Working depths of up to 250mm and working widths of up to 300mm are possible, depending on the size of the share used.

AGRIMAL (MALAWI) LTD.
P.O. Box 143, Blantyre
MALAWI

BULAWAYO STEEL PRODUCTS
8 Ironbridge Road, Donnington
P.O. Box 1603, Bulawayo
ZIMBABWE

BAIN MANUFACTURING COMPANY (PVT) LTD.
Box 1180, Harare
ZIMBABWE

IDEAL CASEMENTS (E.A.) LTD.
Box 45319, Nairobi
KENYA

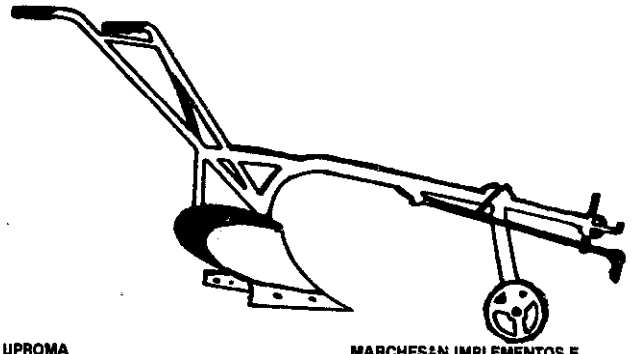
MAMUKI INDUSTRIES
P.O. Box 88, Ruiru
KENYA

Zimplow offer an optional light-weight ripper tine attachment for hard soil conditions.

ZIMPLOW LTD
HIS Steelworks Road
Box 1059, Bulawayo
ZIMBABWE

A very similar plough, differing only in the handle design (which includes fewer bracing rods), is manufactured in West Africa. Working depths of between 75 and 2000mm, and a gross weight of around 38kg are usual.

SISMAR
B.P. 3214, 20 rue Dr Theze, Dakar
SENEGAL



UPROMA
B.P. 1086, Lomé
TOGO

C.N.E.A.
B.P. 7240, Ouagadougou
BURKINA FASO

Indian-manufactured ploughs of this kind are, again, very similar to those already described. Performance and weight are not significantly different, although the handles are more heavily braced that those produced in West Africa.

NEW VIJAY INDUSTRIES LTD.
P.O. Willingdon College
Vishrambag, Sangli 416 415,
Maharashtra
INDIA

EICHER GOODEARTH LTD.
Deepak 3rd Floor
13 Nehru Pl., New Delhi 110019
INDIA

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

Marchesan manufacture a heavy-duty and light-weight implement (illustrated above right).

MARCHESAN IMPLEMENTOS E MÁQUINAS AGRÍCOLAS TATÚ S.A.
C.P. 131, 15.990 Matão SP
BRAZIL

Bayerische Pflugfabrik produce 3 models of this kind of plough, (SP12M, SP14M, SP18M), with working depths of 150 and 240mm.

BAYERISCHE PFLUGFABRIK GmbH
Postfach 80
Von-Kühlmann-Straße 25
8910 Landsberg A. Lech
W. GERMANY

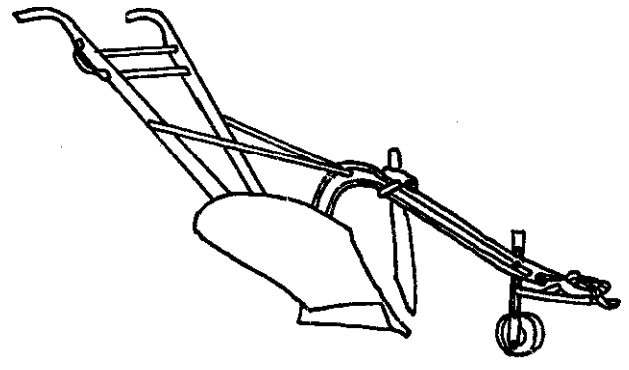
Other manufacturers of this kind of mouldboard plough include:

NARDI FRANCESCO & FIGLI
06017 Selci Lama, Perugia
ITALY

MARPEX
1 rue Thurot, 44000 Nantes
FRANCE

E.B.R.A.
28 rue du Maine, B.P. 915
49009 Angers Cedex
FRANCE

SAHALL LTD.
Soil and Water Resources
13 Leachfield Industrial Est.
Garstang, Preston PR3 1PR
U.K.



ROLLING-COULTER PLOUGH

The class of plough described here differs from those listed above only by the addition of a knife — or in some cases, a rolling-coulter. The coulter, which is mounted directly in front of the plough share, serves to make the initial cut in the soil, thereby creating a smoother passage for the main plough body.

K.K. Lien produce an optional rolling-type coulter (illustrated).

K.K. LIEN, FABRIKKA/s
Tromøy, Arendal, 4812 Kongshamn
NORWAY

BAYERISCHE PFLUGFABRIK GmbH
Postfach 80
Von-Kühlmann-Straße 25
8910 Landsberg a. Lech
W. GERMANY

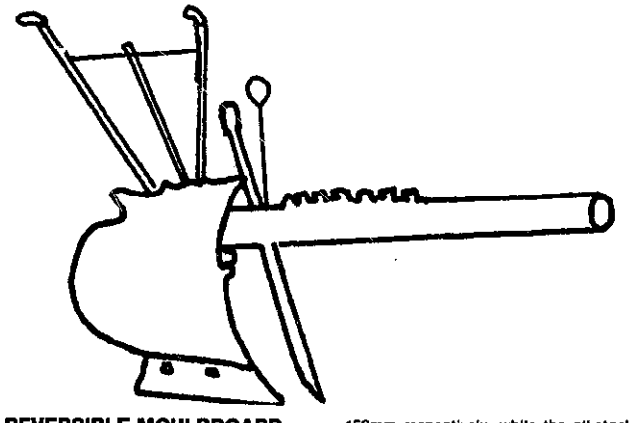
Nardi also produce a heavy-duty plough of this type.

NARDI FRANCESCO & FIGLI
06017 Selci Lama, Perugia
ITALY

ET. TÉCHINÉ
82400 Valence d'Agen (T&G)
FRANCE

S.M.E.C.M.A.
B.P. 1707, Bamako
MALI

S.C.A.D. BOURGUIGNON
B.P. 17
26301 Bourg-de-Péage-Cédex
Drome
FRANCE



REVERSIBLE MOULDBOARD PLOUGHS

Otherwise called a revolving plough, the reversible plough consists of a double plough body (see illustration), one side of which turns the soil to the left, the other to the right. This reduces operation time and leaves a level field.

The U-070 revolving plough (illustrated) is designed for use on small fields in hilly areas, and gives a working depth and width of up to 180 and 240mm respectively. Weight is 36kg.

Manufactured by Metalowa Spółdzielnia Pracy and available through:

AGROMET MOTOIMPORT
Foreign Trade Enterprise
P.O. Box 990, Warsaw
POLAND

A slightly larger range of reversible ploughs is produced by 2 Brazilian manufacturers. These implements are equipped with an adjustable gauge wheel and are available in 3 sizes. The 2 models with a wooden beam weigh 22 and 36kg with working depths of 130 and 150mm respectively, while the all-steel plough weighs 42kg and works to a depth of 150mm.

BALDAN IMPLEMENTOS AGRÍCOLAS S.A.
Av. Baldan 1500, C.P.11
15.990 Matão S.P.
BRAZIL

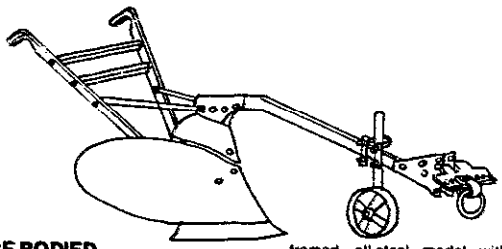
MARCHESAN IMPLEMENTOS E MÁQUINAS AGRÍCOLAS TATÚ S.A.
C.P. 131 15.990 Matão SP
BRAZIL

Reversible ploughs of a similar type are manufactured by:

S.C.A.D. BOURGUIGNON
B.P. 17
26301 Bourg-de-Péage-Cédex
Drome
FRANCE

I.C.A.
Programa de Maquinaria Agrícola
Apartado Aéreo 151123, Bogotá
COLOMBIA

(The plough by ICA Informa is attached to a toolbar.)



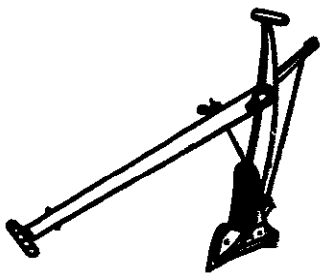
LARGE-BODIED MOULDBOARD PLOUGHS

MODEL 75 WALKING PLOUGH by Hochstetler (illustrated) is a heavy-duty implement consisting of a high-carbon steel beam, wooden handles, gauge wheel and a large 300 or 350mm plough body. The plough body is available as either left- or right-handed.

Rumpstad manufacture a lighter-framed, all-steel model with a long mouldboard for use on heavy or medium soil conditions.

D.A. HOCHSTETLER & SONS
R.R.2, Box 162, Topeka IN 46571
U.S.A.

RUMPSTAD B.V.
3243 ZG Stad Aan't-Haringvliet
Postbus 1
HOLLAND



REVERSIBLE PLOUGH WITH RIBBED MOULDBOARD

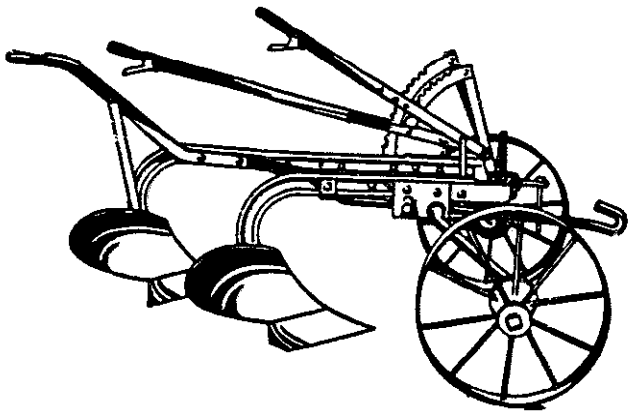
The ribbed mouldboard's simpler share design allows the face to be turned left or right by means of a shift-lever.

The Model ILTH Alternate Single-Share Plough manufactured in China has a weight of 47kg and working depths of 180-230mm. It is not designed for animal draught and is supplied for use with a walking tractor. This plough is manufactured by Cheggu Farm Machine Works and is available through:

CHINA NATIONAL AGRICULTURAL MACHINERY IMPORT AND EXPORT CORPORATION
26 South Yeutan Street, Beijing, CHINA

The plough produced by Cecoco (illustrated) is available in 3 sizes (18, 20, 30kg), and has a capacity of 2-3 ha/day.

CECOCO
P.O. Box 8, Ibaraki City
Osaka Pref. 567, JAPAN



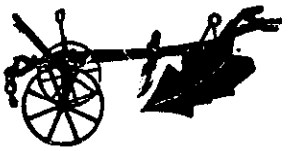
TWO-WHEELED PLOUGHS

P23 DOUBLE-FURROW PLOUGH
Equipped with a land lever for depth control and twin 250mm mouldboards, this plough (illustrated) requires the draught power of 8 oxen.

ZIMPLOW LTD.
HIS Steelworks Road,
Box 1059, Bulawayo
ZIMBABWE

MODEL 60 SULKY PLOUGH
Designed to be drawn by a team of 3 or 4 horses, the Model 60 is a large, single-furrow plough with the unusual addition of a rolling landside which reduces draught weight. It is also equipped with a front furrow caster wheel which automatically controls the cutting width (300-500mm) and depth.

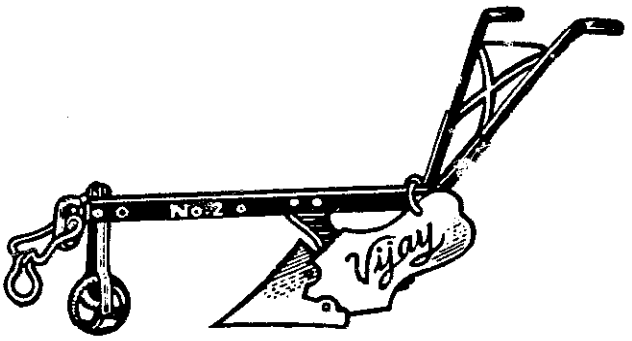
D.A. HOCHSTETLER & SONS
R.R.2, Box 162, Topeka IN 46571
U.S.A.

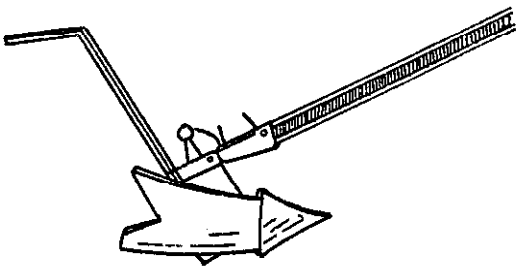


TWO-WHEELED PLOUGHS

Other manufacturers of large 2-wheeled ploughs include Nardi of Italy. A range of mouldboard (working depth of up to 550mm) and turnwrest (working depth of up to 500mm) ploughs is available.

NARDI FRANCESCO & FIGLI
06017 Selci Lama, Perugia
ITALY





SINGLE-FURROW TURNWREST PLOUGHS

Turnwrest refers to the design of the plough body which, in this case, resembles an inclined arrowhead (the share) and elongated board (the breast). Turnwrest ploughs are by definition reversible, being able to turn the soil either to the left or right. They are ideally suited for primary cultivation in hilly regions or in areas with heavy soil conditions.

Turnwrest ploughs are extensively used in India where a number of manufacturers produce a range of ploughs of varying size and specifications.

VIJAY PLOUGHS
6 implements ranging from the smallest, which weighs 46kg (illustrated), to the largest which has a weight of 94kg. Respective working depths are 100-130mm and 200-250mm.

NEW VIJAY INDUSTRIES LTD.
P.O. Willingdon College
Vishrambag, Sangli 416 415
Maharashtra
INDIA

Similar ploughs are manufactured by:

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

DANDEKAR BROTHERS
(Engineers & Founders)
Sangli — Shivaji Nagar, 416416
Maharashtra
INDIA

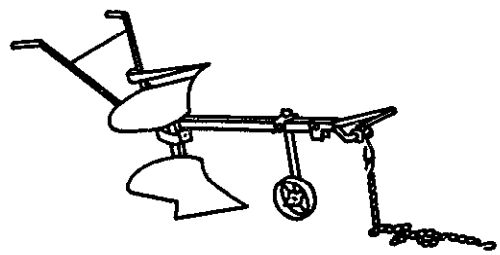
MAHARASHTRA AGRO INDUSTRIAL DEVELOPMENT CORPORATION LTD.
Rajan House, 3rd Floor
Near Century Bazar, Prabhadevi
Bombay 400 025
INDIA

European manufacturers include Nardi of Italy, who produce a turnwrest plough without a gauge wheel (lower illustration) which, depending upon the size of plough body used, can achieve a working depth of up to 350mm.

NARDI FRANCESCO & FIGLI
06017 Selci Lama, Perugia
ITALY

A range of 5 simple wooden turnwrest ploughs are produced by:

COMPANHIA INDUSTRIAL DE FUNDICAO
17 rue de Sao Joao 27, 4000 Porto
PORTUGAL

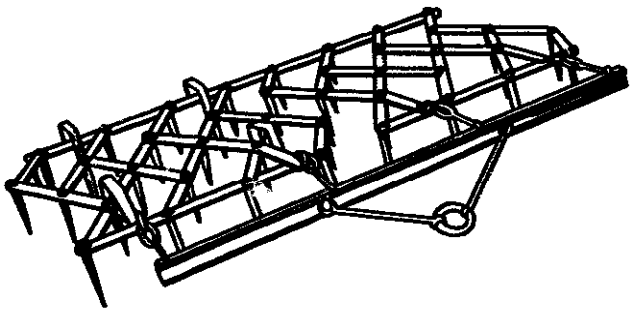


TWIN-BODIED REVERSIBLE PLOUGHS

The plough by Sismar (illustrated) is equipped with 2 cylindrical-helical mouldboards with an interchangeable ploughshare and landside. The weight of the plough is 50kg and it has a working depth of 180-200mm. Nardi produce a range of very large reversible ploughs (2-wheeled) which employ a similar rotating mechanism.

SISMAR
B.P. 3214, 20 rue Dr Theze, Dakar
SENEGAL

NARDI FRANCESCO & FIGLI
06017 Selci Lama, Perugia
ITALY



DIAMOND HARROWS

DIAMOND HARROW An all-steel harrow measuring 140 x 65 x 20cm. Light, medium and heavy sections are available weighing 26, 28 and 31kg respectively. Draw-bar hitches are available for use with more than one section.

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

DIAMOND HARROW This model (illustrated) is available with 1, 2, 3 or 4 sections complete with draw bar. The teeth have a 16mm square cross section, and are 195mm long with a 30mm thread. The 2 section harrow with drawbar weighs 59.2kg.

AGRIMAL (MALAWI) LTD.
P.O. Box 143, Blantyre
MALAWI

BAIN MANUFACTURING COMPANY (PVT) LTD.
Box 1180, Harare
ZIMBABWE

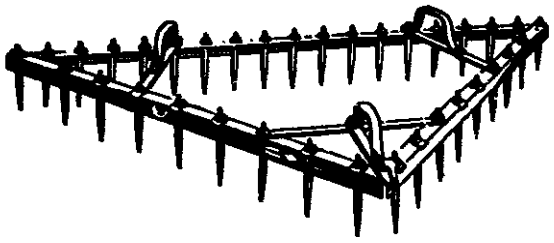
BULAWAYO STEEL PRODUCTS
8 Ironbridge Road, Donnington
P.O. Box 1603, Bulawayo
ZIMBABWE

ZIMPLOW LTD.
HIS Steelworks Road
Box 1059, Bulawayo
ZIMBABWE

SPIKED DIAMOND HARROW Each section has 20-25 forged tines, and two or more sections may be linked together.

ELISHA ENGINEERING
38 Nabeka Street, P.O. Box 42, Ba
FIJI

RAM NARAYAN ENGINEERING
Koula Road, P.O. Box 271, Ba
FIJI



TRIANGULAR HARROWS

These harrows have a triangular shaped frame to which the tines are attached. Weights can be added on top of the frame for deeper penetration.

HARROW A new light-weight harrow made out of box section steel has been designed to cover a width of 2m. Being light, it can be used to cover over maize after planting. It has a depth hake so that it remains level after being loaded with weights.

LUGARI EXTENSION PROGRAM
Appropriate Implements Project
P.O. Box 125, Soy
KENYA

TRIANGULAR HARROW
This light-weight harrow (illustrated) weighing 30kg is fitted with 35 teeth 16mm square in section and 150mm long. Sledge attachments are available.

ZIMPLOW LTD.
HIS Steelworks Road
Box 1059, Bulawayo
ZIMBABWE

AGRIMAL (MALAWI) LTD.
P.O. Box 143, Blantyre
MALAWI

BAIN MANUFACTURING COMPANY (PVT) LTD.
Box 1180, Harare
ZIMBABWE

BULAWAYO STEEL PRODUCTS
8 Ironbridge Road, Donnington
P.O. Box 1603, Bulawayo
ZIMBABWE

A similar harrow weighing 34kg is made by Cossul. It is 185cm wide.

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

WOODEN HARROW
A small, 14-toothed harrow with a cutting width of 1.3m and working depth of 12cm, weighing 48kg. A 16-toothed model is also available.

MARCHESAN IMPLEMENTOS E MÁQUINAS AGRÍCOLAS TATÚ S.A.
C.P. 131, 15.990 Matão SP
BRAZIL

STEEL HARROW
Marchesan also produce an all-steel, 15-toothed harrow with adjustable width. It has a maximum cutting width of 1.4m, a working depth of 12cm and weighs 52kg.

MARCHESAN IMPLEMENTOS E MÁQUINAS AGRÍCOLAS TATÚ S.A.
C.P. 131, 15.990 Matão SP
BRAZIL

BALDAN IMPLEMENTOS AGRÍCOLAS S.A.
Av. Baldan 1500, C.P. 11
15.990 Matão SP
BRAZIL

BROAD-TOOTH HARROWS

SPOON-TOOTH HARROW
The spoon tooth harrow illustrated has 20 steel teeth. It is 1.1m wide and 1.36m long and weighs 50kg. The working depth is adjustable.

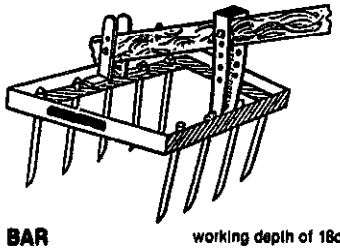
DOV YODLA & SONS
P.O. Box 246, Givatayim 53102
ISRAEL

PEG TOOTH HARROW
The 30-tooth harrow weighs 51kg and can cover up to 2ha per day. 18- and 25-toothed models are also available. A lever is provided for adjusting the angle of the teeth.

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

TWO-ELEMENT HARROW
A harrow designed for use in a gang of two elements. Each element has 15 teeth 14mm in diameter arranged in five rows. It has sledge attachments for easy transportation.

S.M.E.C.M.A.
B.P. 1707, Bamako
MALI

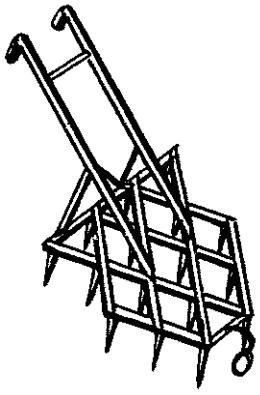


SPIKED-TOOTH BAR HARROW

The bar harrow is used for breaking up the soil crust and weeding. It consists of a wooden beam, steel frame and nine replaceable threaded teeth. A steel towing bar with chain linkage can be provided. The overall working width is 2.1m. The harrow weighs 80kg and has a working depth of 18cm.

EICHER GOODEARTH LTD.
Deepak 3rd Floor
13 Nehru Pl., New Delhi 110019
INDIA

UNION FORGINGS
Focal Point, Sherpur, Ludhiana, Punjab
INDIA



SINGLE-SECTION WALKING HARROWS

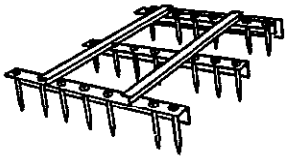
16-TINE HAND HARROW
Consisting of a bolted-together framework and tubular handles, this harrow (illustrated) is equipped with 16 rigid tines arranged into 5 rows. It can be applied to either secondary tillage operations or weed control work between planted rows, and requires the draught power of a single bullock.

ELISHA ENGINEERING
38 Nabeka Street, P.O. Box 42, Ba
FIJI

RAM NARAYAN ENGINEERING
Koula Road, P.O. Box 271, Ba
FIJI

34-TINE WALKING TRIANGULAR HARROW
Essentially similar to a conventional triangular harrow, this implement is distinguished by the addition of a tubular steel handle framework. The main frame is fabricated from L-section angle iron, welded to form an isosceles triangle, the short side (75cm) being at the rear. The two equal sides are 1m in length. The spiked tines are circular in section with a 1cm diameter, and are arc-welded to the frame at 10cm intervals.

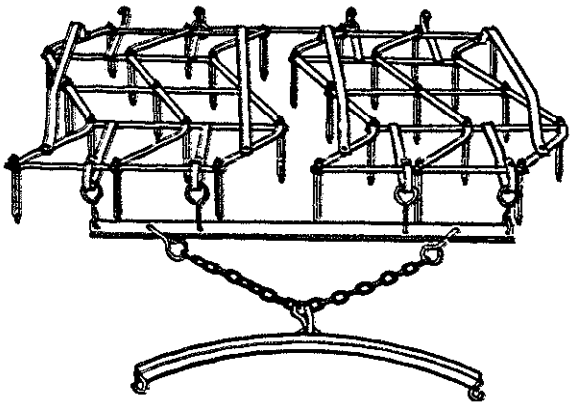
G.I.A.
Ricardo Matte Pérez 0324
Casilla 6122, Correo 22, Santiago
CHILE



SQUARE HARROW

The frame of the square harrow is two T-sections. It has 21 threaded teeth and a levelling board.

RUMPSTAD B.V.
3243 ZG Stad Aan't-Haringvliet
Postbus 1
HOLLAND



ZIGZAG HARROWS

So called because of the zigzag formation of the framework, these harrows are equipped with fixed vertical tines and are manufactured in a wide range of weights and sizes. The lightest type, which may have a track of up to 5m, is used for covering over broadcast seeds, and has relatively short tines. The heavier animal-drawn zigzag harrows have a narrower track and larger tines for better penetration in hard soil conditions.

Zigzag harrows are usually used in 'gangs' where the desired track width is made up with one or more harrow units. For animal-drawn implements, the maximum number of gangs is normally 4, depending on the weight of the harrow and the draught power available.

For transportation purposes, zigzag harrows are fitted with metal skids on the upper side of the framework.

The following manufacturers produce 2-, 3- or 4-gang, 16-tooth harrows (4 rows of 4 teeth). They are available in three sizes — light, medium and heavy — with gang weights ranging from 26 to 40kg. Teeth are 200-225mm in length with a 30 × 12mm section.

AGRIMAL (MALAWI) LTD.
P.O. Box 143, Blantyre
MALAWI

BAIN MANUFACTURING COMPANY (PVT) LTD.
Box 1180, Harare
ZIMBABWE

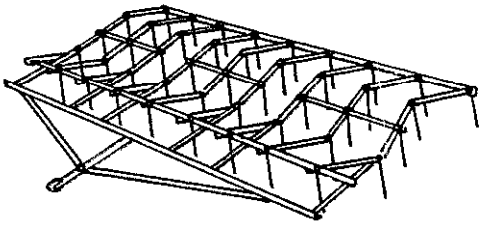
BULAWAYO STEEL PRODUCTS
8 Ironbridge Road, Donnington
P.O. Box 1603, Bulawayo
ZIMBABWE

ZIMPLOW LTD.
HIS Steelworks Road
Box 1058, Bulawayo
ZIMBABWE

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

Similar 1-, 2- or 3-gang, 15-tooth harrows (5 rows of 3 teeth) are produced by the following manufacturers. Single-gang width is about 0.8m with a weight of 28kg. The equipment manufactured by Marpex is illustrated.

SISMAR
B.P. 3214, 20 rue Dr Theze, Dakar
SENEGAL



AGRICOLA
34 rue Beni Amar, Casablanca
MOROCCO

ETS. TÉCHINÉ,
82400 Valence d'Agen (T&G)
FRANCE

S.C.A.D. BOURGUIGNON,
B.P. 17, 26301 Bourg-de-Péage-Cedex

'AFTER-SOW' HARROW

A range of light-weight animal-drawn zigzag harrows is produced by Polish manufacturers, among which: the U-253/3 harrow consists of three 20-tine gangs and weighs 63kg, track width is 2.76m (illustrated); the U-255 harrow consists of four 20-tine gangs and weighs 73kg, track width is 3.68m.

Manufactured by Agromet-Unia, and obtained through:

AGROMET MOTOIMPORT
Foreign Trade Enterprise
P.O. Box 990, Warsaw
POLAND

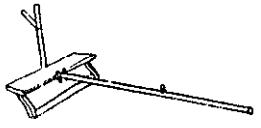
Drome
FRANCE

MARPEX
1 rue Thurot, 44000 Nantes
FRANCE

RAU MASCHINENFABRIK GmbH
Johannes-Rau-Straße
7315 Weilheim an der Teck
W. GERMANY

The 'Long Harrow' (not illustrated) is produced by Swan Foundry. Each gang is longer than conventional and consists of 8 rows of 4 tines, and for 3 such gangs the equivalent draught power of 3 horses is required. Also manufactured is the 'Super Long Harrow'.

SWAN FOUNDRY
Langley, Claverdon, Warwickshire
U.K.



STEEL HARROW

The Krushi Udyog steel harrow is primarily used for preparing soil prior to sowing, although it may also be used for harvesting root crops and inter-cultivation operations.

MAHARASHTRA AGRO IND. DEV. CORPORATION LTD.
Rajan House, 3rd Floor
Near Century Bazaar,
Prabhadevi, Bombay 400 025
INDIA

DISC HARROWS

The disc harrow is probably the most efficient type of harrow for breaking up the soil. It may be used both for secondary tillage and for cutting up the surface of grassland to promote aeration.

The harrow comprises two gangs of discs attached to a framework which usually carries the shaft and driver's seat. The gangs are hinged and, by means of a ratchet lever, the angle they form with the line of draught can be varied. This angle determines the depth of penetration of the discs. Because both gangs are set at similar angles the direction of the harrow is maintained: there is no sideways pull.

3-DISC GANG HARROWS
Manufacturers of 3-disc gang harrows include:

STANDARD AGRICULTURAL ENGINEERING CO.
824 & 825 Industrial Area B
Ludhiana A-141 003, Punjab
INDIA

ALLIED TRADING COMPANY (INDIA)
Railway Road, Ambala City, Haryana
INDIA

INTERNATIONAL MFG. CO. (REGD.)
Hospital Road, Jagraon
Ludhiana, Punjab
INDIA

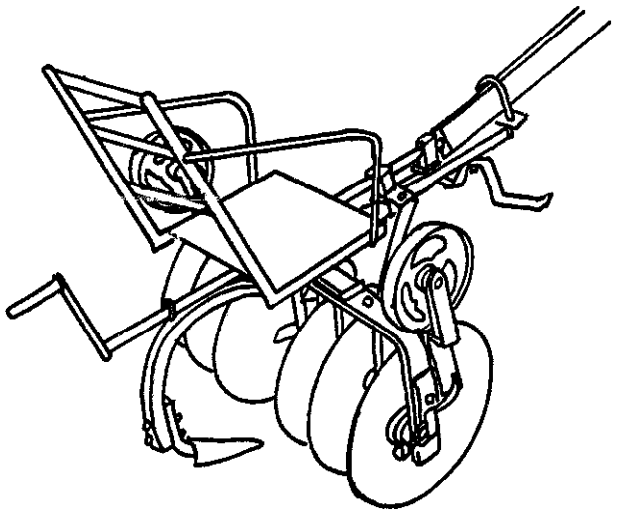
MOHINDER & CO. ALLIED INDUSTRIES
Kurali, Distt. Ropar, Punjab
INDIA

UNION FORGINGS
Focal Point, Sherpur
Ludhiana, Punjab
INDIA

ZANA ZA KILIMO LTD.
P.O. Box 1186, Mbeya
TANZANIA

I.C.A. INFORMA also produce a 3-disc gang harrow of 2 units, giving a total of 12 discs. The 2 units, which are essentially similar, are joined back to front by a flexible coupling.

I.C.A.
Programa de Maquinaria Agricola
Apartado Aéreo 151123, Bogotá
COLOMBIA



4-DISC GANG HARROWS
Manufacturers of 4-disc gang harrows include:

COSSUL & CO. PVT. LTD.
123/367 Industrial Area, Fazalgunj
Kanpur, U.P.
INDIA

SATHIYAWADI STORES AND MOTOR TRANSPORTERS LTD.
P.O. Box 42, Kurunegala
SRI LANKA

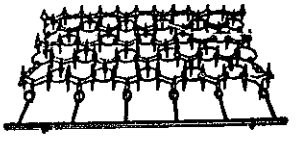
MARCHESAN IMPLEMENTOS E MÁQUINAS AGRÍCOLAS TATÚ S.A.
C.P. 131, 15.990 Matão SP
BRAZIL

I.C.A.
Programa de Maquinaria Agricola
Apartado Aéreo 151123, Bogotá
COLOMBIA

5-DISC GANG HARROWS
Manufacturers of 5-disc gang harrows include:

ETS. TÉCHINÉ
82400 Valence d'Agen (T & G)
FRANCE

BALDAN IMPLEMENTOS AGRÍCOLAS S.A.
Av. Baldan 1500, C.P.11
15.990 Matão SP
BRAZIL



CHAIN HARROW

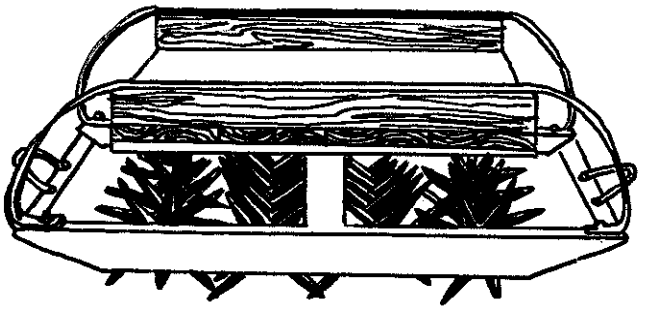
The chain harrow comprises up to 5 rows of interlinking 'tridents' (3 spiked teeth mounted on a steel ring). Two working widths of 1.5 and 1.75m are available with weights ranging from 32 to 77kg.

NARDI FRANCESCO & FIGLI
06017 Selci Lama, Perugia
ITALY

FLEXIBLE HARROW

Each row of 3 tines is able to move independently. The harrow has a working width of 0.6m, a length of 1.3m and weighs 21kg.

DOV YODLA & SONS
P.O. Box 246, Givatayim 53102
ISRAEL



ROTARY HARROWS

Similar in principle to the disc harrow, the rotary harrow comprises a frame into which one or more rows of either spiked (starred) teeth or chopping blades are mounted. The movement of the harrow over the ground causes the teeth or blades to rotate and break up the soil.

The rotary harrow made by K.K. Lien (illustrated) has 4 rows of steel teeth and is available in 4 sizes. Working widths and weights are 80cm/87kg, 97cm/123kg, 120cm/148kg and 140cm/176kg.

Also available from K.K. Lien is a rotary cultivator with 2 adjustable tooth-axles. It has a working width of 120cm and weighs 90kg.

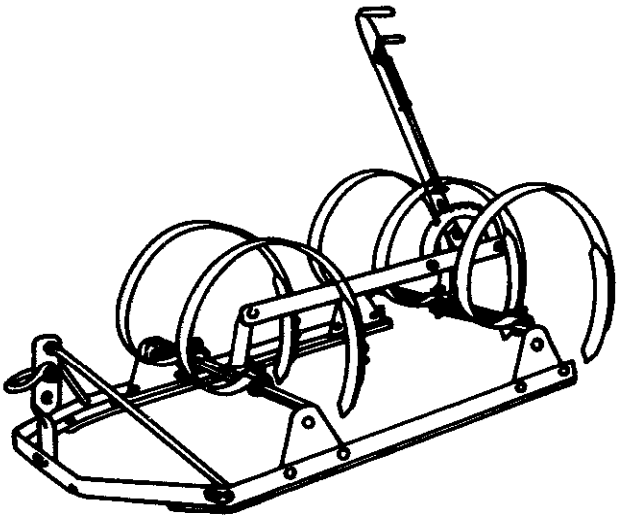
K.K. LIEN FABRIKK A/S
Tromøy, Arendal
4812 Kongshamn
NORWAY

Other rotary harrows include an implement similar in design to the model illustrated, which has two 6mm plate spike-tooth wheels.

SISMAR
B.P. 3214
20 rue Dr These, Dakar
SENEGAL

A third rotary harrow, the Mod.420 Crumbler, is equipped with 2 rows of steel wires welded into spike wheels. This weighs 57kg and has a working width of 128mm.

DOV YODLA & SONS
P.O. Box 246, Givatayim 53102
ISRAEL



SPRING-TOOTH HARROWS

Spring-tooth harrows can be used for secondary tillage (in the same way as conventional harrows), or for other cultivation purposes. An important advantage of spring-tooth instruments is their resistance to damage by obstacles in the ground such as large stones. When an obstacle is hit, the sprung tooth will bend rather than take the impact of the whole draught capacity.

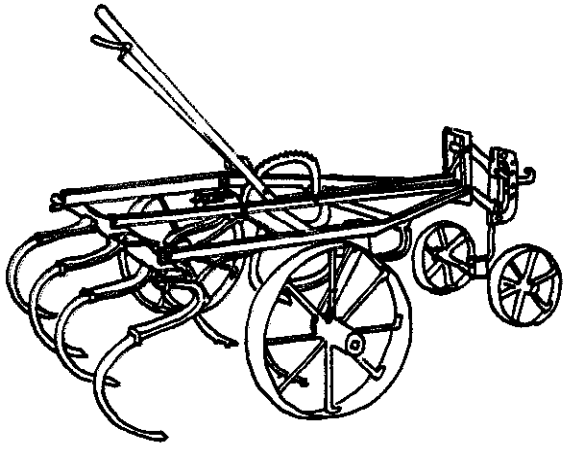
These harrows are constructed from angle steel with the teeth fastened to a tubular steel bar. The tempered steel teeth have reversible points, and are adjusted with a shift lever.

The harrow by Cossul (illustrated) is able to work to a depth of 150mm and weighs 40kg (5 teeth) or 57kg (7 teeth).

A similar, 9-tooth, harrow is made in 3 sizes by K.K. Lien. Working widths and weights are 60cm/59kg, 80cm/67kg, and 110cm/84kg.

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

K.K. LIEN FABRIKK A/S
Tromøy, Arendal
4812 Kongshamn
NORWAY



SPRING-TINED CULTIVATORS

Similar in function to the spring-tooth harrows, these cultivators are designed to be drawn by a pair of horses or oxen.

U-407/0 SPRING-TINE CULTIVATOR
It has 5 replaceable spring tines, each with a doubled-edged point. The working depth of the tines can be set by a control lever. This raises or lowers a frame to which the tines are attached.

Specifications include:
working depth: up to 15cm
working width: 75cm.
average output: 0.25 ha/h
total weight: 85kg

This cultivator is manufactured by Wytwornia Urzadzeń Komunalnych of Kalisz and is available through:

AGROMET MOTOIMPORT
Foreign Trade Enterprise
P.O. Box 980
Warsaw
POLAND

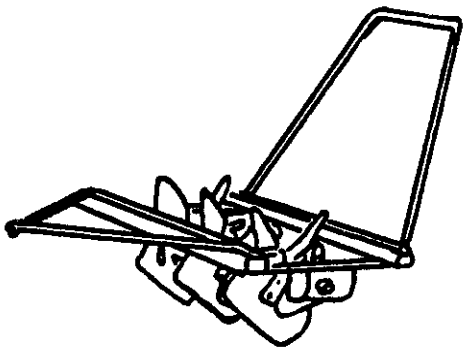
HORSE-DRAWN CULTIVATOR
This cultivator is manufactured with 9 or 11 tines with respective working widths and weights of 80cm/140kg and 120cm/160kg. Depth of cultivation is regulated by a shift lever which is coupled to all 4 wheels. This allows the support frame always to be parallel to the ground.

K.K. LIEN FABRIKK A/S
Tromøy, Arendal
4812 Kongshamn
NORWAY

SC12 CULTIVATOR

Also available is the SC12 horse-drawn cultivator with spring tines adaptable for 2- or 3-horse draught:

CARTHORSE CO. LTD.
Egremont Farm, Payhembury
Honiton, Devon EX14 0JA
U.K.



PUDDLERS

Puddlers are used for the preparation of rice paddies prior to planting.

The principle of puddling is important in rice growing because it both preserves the soil's integrity and reduces field water losses. Before transplanting paddy seedlings from the nursery, the field into which they are to be moved is flooded with water. The soil is then agitated into suspension by a puddling instrument, and left to settle. The heavier soil particles will settle first, followed more slowly by the finer silts and clays which 'seal' off the top layer of soil. The result is that the overall permeability of the field will be reduced, although it takes a number of years to establish good water efficiency.

Rotary puddlers (illustrated) are manufactured by:

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

ANDHRA PRADESH AGRI UNIVERSITY
Rajendranagar, Hyderabad 500 030
INDIA

MODERN ENGINEERING COMPANY
1A Anna Street, Velandi Palayam
Coimbatore 641 025, Tamil Nadu
INDIA

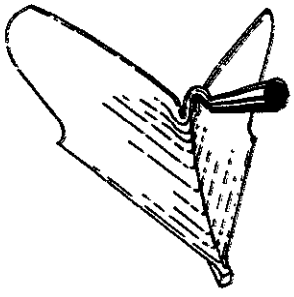
P.T. BUMA SAKTI
Jl. Suriani 8, Bandung
INDONESIA

Wooden puddlers with fixed dishes are manufactured by:

C.V. MUSUHAMA
Jl. Raya Kajen 248
Tegal, Jawa
INDONESIA

BINA PRODUKSI TANAMAN PANGAN, DIT.
Pasar Minggu, Jakarta
INDONESIA

METAL INDUSTRIES DEV. CENTER
Jalan Sangkuriang 12
P.O. Box 113, Bandung
INDONESIA



HAND RIDGERS

Hand ridgers are employed in manual land forming and intercultivation operations. When attached to a handle-bar they can be pulled through the soil to form ridges.

HAND RIDGER

MANUFACTURE FRANCAISE DE FOURCHES
3 rue de Lyon, Terrenoire, B.P. 4
42011 Saint-Etienne Cedex
FRANCE

HEAPER
The 'heaper' is available in 2 sizes. The No.3H5 is 20cm wide, while the 3H6 model has a width of 26cm.

POLAR WERKE GmbH
Postfach 14 04 60
5630 Remscheid 1
W. GERMANY

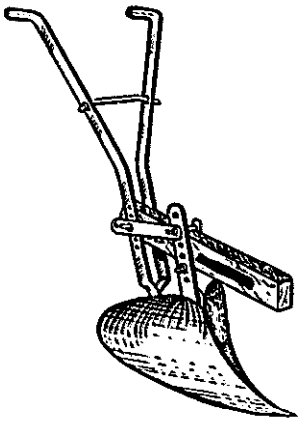
RIDGER
This is a tool for ridging, earthing up vegetables, trenching etc., and can be pulled through the soil at walking pace.

WOLF TOOLS LTD.
Ross-on-Wye, Herefordshire HR9 5NE
U.K.

EARTHING PLOUGH
This is a hand-drawn tool with a seamless steel blade for planting and earthing over potatoes, tracing irrigation channels etc.

HAND-DRAWN PLOUGH
When fitted with a guiding and pulling handle, this plough makes an excellent tool for planting and harvesting potatoes, and can be operated by two people.

NORBERGS AB SPAD-REDSKAPSFABRIKER
Vintergatan 7, 59132 Motala
SWEDEN



SIMPLE RIDGING PLOUGHS

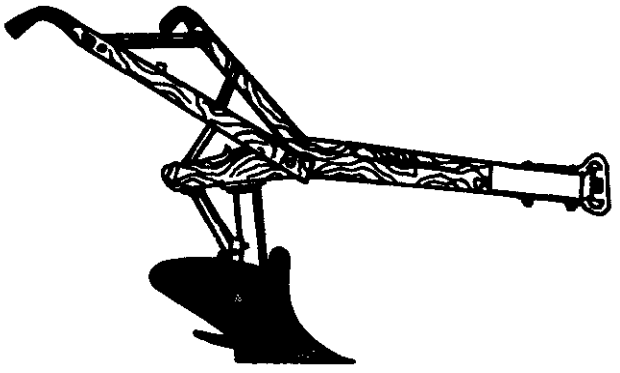
Whilst basically similar in function to the hand ridgers, the ridging ploughs described below are all animal drawn and have adjustable linkages.

RIDGING PLOUGH
The mouldboard can be fitted with a removable tail piece which increases the working width from 68cm to 78cm. The depth of cut is 20cm and the overall weight is 40kg. (Illustrated)

EICHER GOODEARTH LTD.
Deepak 3rd Floor
13 Nehru Pl., New Delhi 110019
INDIA

RIDGER PLOUGH
A similar plough is produced by Union Forgings:

UNION FORGINGS
Focal Point, Sherpur
Ludhiana, Punjab
INDIA



RIDGING PLOUGHS (without land wheel)

ASTT SUPER TATU RIDGER PLOUGH
This plough (illustrated) is designed for opening furrows for planting and burying manure, stubble and chemical fertilizer. All parts are steel except the handles and beam. Total weight 31kg.

MARCHESAN IMPLEMENTOS E MAQUINAS AGRICOLAS TATU S.A.
C.P. 131, 15.990 Matão SP
BRAZIL

DELTA RIDGER
A triangular-shaped ridger for making ridges or furrow. It may be adjusted to different widths and is able to cover up to 1 to 2 hectares/day. Its weight is 40kg.

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

RIDGING PLOUGHS
Chok Chareon produce a variety of all-metal ridging ploughs with curved beams in a range of different sizes.

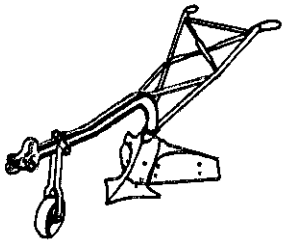
CHOK CHAROEN
724/5 Kor Po-thong Road,
A. Muang, Chonburi
THAILAND

RIDGER
This is an all-metal ridger with a bent beam and draw bar assembly with linkage towards the back of the beam.

AGRICOLA
34 rue Beni Amar
Casablanca
MORROCO

VIJAY RIDGER No.2
This small size Ridger/Cultivator is useful for sugar-cane farming. The wings can be adjusted according to the size of furrow required, which can be up to 30cm deep and 62cm wide. It weighs 53kg and requires two bullocks.

NEW VIJAY INDUSTRIES LTD.
P.O. Willingdon College
Vishrambag, Sangli 416 415
Maharashtra
INDIA



RIDGING PLOUGHS

The ridging ploughs featured below are ideally suited for crops which grow on ridges, such as potatoes, groundnuts and cotton. The ridger consists of a share, two wings and a breastplate, which are attached to a bent beam. At the front of the beam is a draught linkage and an adjustable land wheel. The plough has two handles and weighs about 40kg.

Rumpstad of Holland produce an all-metal ridging plough.

RUMPSTAD B.V.
3243 ZG Stad Aan't-Haringvliet
Postbus 1
HOLLAND

A similar 'high wing' ridger is produced in Malawi and Zimbabwe (illustrated left). It has extra bracing in the handle and a cross clevis. The wings are adjustable for row widths of 400-750mm.

AGRIMAL (MALAWI) LTD.
P.O. Box 143, Blantyre
MALAWI

BULAWAYO STEEL PRODUCTS
8 Ironbridge Road, Donnington
P.O. Box 1603, Bulawayo
ZIMBABWE

ZIMPLOW LTD.
HIS Steelworks Road
Box 1059, Bulawayo
ZIMBABWE

BAIN MANUFACTURING COMPANY (PVT) LTD.
Box 1160, Harare
ZIMBABWE

A design with wooden handles and beam is produced in Burkina Faso and Togo. The ridger body can be removed and other cultivating attachments fitted.

CNEA consists of a manufacturing network of two primary workshops (Arcoma) and 10 secondary workshops (Corema) spread throughout Upper Volta. The primary workshops at Bobo and Tenkodogo receive supplies of the parts from Abidijan and Lomé and machine the raw materials.

The secondary workshops bend, solder, weld and paint the various components before assembling and distributing the finished items.

C.N.E.A.
B.P. 7240, Ouagadougou
BURKINA FASO

UPROMA
B.P. 1088, Lomé
TOGO

KAPAS (EMCOT) RIDGER
This ridger can be used for cultivating cotton, corn and other crops planted in rows. The beam, mouldboard and handles are made of steel, and tail pieces are provided for increasing the furrow width. The plough weighs 44kg and covers up to 3 to 4 acres per day.

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

HOLTAG 'EMCOT' RIDGER
Widely used in the northern parts of Nigeria, Ghana and Zaire.

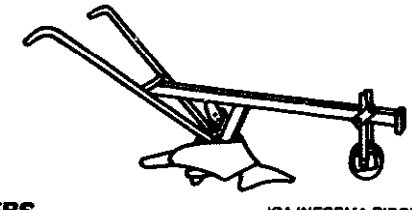
JOHN HOLT AGRICULTURAL ENGINEERS LTD.
New Industrial Estate
P.O. Box 352, Zaria
Kaduna State
NIGERIA

VIJAY RIDGER No.1
A medium-sized ridger for sugar-cane. The wings can be adjusted to give a furrow 60 to 90cm wide and 23 to 25cms deep. It requires two bullocks and weighs about 90kg.

NEW VIJAY INDUSTRIES LTD
P.O. Willingdon College
Vishrambag, Sangli 416 415
INDIA

EARTHING PLOUGH
For earthing-up in row cultivation, this ridging plough is of light-weight steel construction weighing only 12kg. It is easy to work and can be either hand-powered or horse-drawn.

K.K. LIEN FABRIKK A/S
Tromøy, Arendal
4812 Kongshamn
NORWAY



RIDGERS

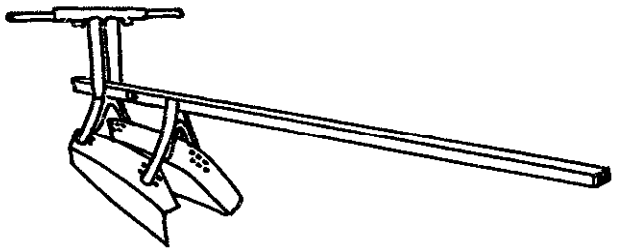
Two examples are given below.

THE OD2 RIDGER
This weighs 42kg and has a working width of 97cm. The frame is square section bars and steel tubing, and the ridging body is adjustable for use in crop lifting. (Illustrated). Available from:

PROJECT EQUIPMENT LTD.
Industrial Estate, Redmal Airfield
West Felton, Oswestry
Salop SY11 4HS, U.K.

ICA-INFORMA RIDGER
This ridger is an attachment to be used on a separate square section frame with land wheel.

I.C.A.
Programa de Maquinária Agricola
I.C.A.
Apartado Aéreo 151123, Bogotá
COLOMBIA



ANIMAL-DRAWN BUND FORMERS

Bund formers consist of a horizontal beam to which, in addition to the walking handle, two collecting mouldboards are attached. The mouldboards are positioned so that the soil is turned inwards from both sides to form a bund. The bund size is controlled by adjusting the mouldboards.

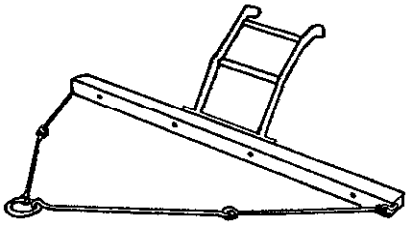
Bund forming is a practice that is used in both wet- and dry-land farming. In the former, (paddy irrigation, for example), bunds are necessary for the containment of near-stationary volumes of water. This is particularly necessary in hilly areas where crops are grown on terraces. In dry-land areas, (and, again, particularly regions of steep terrain), contour bunding is an essential measure for soil and water conservation purposes.

MOHINDER & CO. ALLIED INDUSTRIES
Kurali, Distt. Ropar, Punjab
INDIA

MAHARASHTRA AGRO. IND. DEV. CORPORATION LTD.
Rajan House, 3rd Floor
Near Century Bazaar, Prabhadevi,
Bombay 400 025
INDIA

MODERN ENGINEERING COMPANY
1A Anna Street, Velandi Palayam
Coimbatore 641 025, Tamil Nadu
INDIA

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA



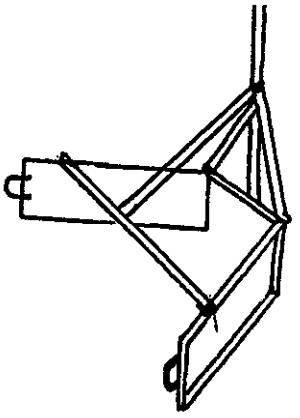
LEVELLING BOARDS

Levelling boards perform a land-forming function by scraping soil from the field surface. This may be done either in the context of a small, one-field operation, or as part of a larger land-forming process. The illustration shows an iron levelling board by Modern Engineering.

MODERN ENGINEERING COMPANY
1A Anna Street, Velandi Palayam
Coimbatore 641 025, Tamil Nadu
INDIA

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

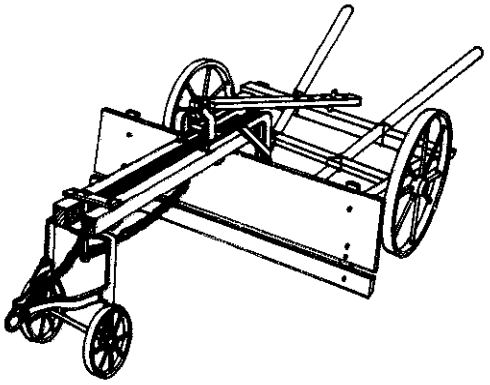
ALVAN BLANCH DEV. CO. LTD.
Chelworth, Malmesbury
SN16 9SG, Wilts.
U.K.



THE SARA YANTRA

The Sara Yantra is a very simple form of bund former used both prior to and after sowing. The two boards are formed so as to 'funnel' the soil towards the rear of the implement. This action results in the soil bulking to form a bund.

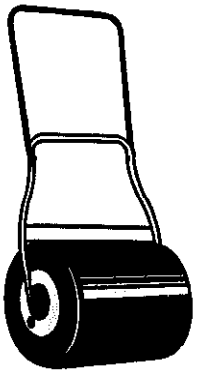
MAHARASHTRA AGRO. IND. DEV. CORPORATION LTD.
Rajan House, 3rd Floor
Near Century Bazar, Prabhadevi,
Bombay 400 025
INDIA



FOUR-WHEELED LEVELLER

The design for this animal-drawn soil leveller was developed over twenty years ago in Valdivia de Paine, Comuna de Buin in the metropolitan area. It uses, in part, second-hand components taken from discarded machinery and locally available wood. It is adjustable both with respect to the height and the angle of the blade which is 185cm wide. A well-ploughed hectare of land free of tree trunks and large stones takes about 10 to 12 days to level properly, using this equipment.

G.I.A.
Ricardo Matte Pérez 0324
Casilla 6122, Correo 22
Santiago
CHILE



ROLLERS

After ploughing, uneven ground can be levelled to some extent by the use of a roller. Rolling is also practised as a secondary tillage operation, to break down clods and consolidate seedbeds.

HAND-PUSHED ROLLER
The illustration shows this roller by Al-Ko. It has a single cyclinder and is designed to be pushed by one person.

AL-KO BRITAIN LTD.
No.1 Industrial Estate
Medomsley Road, Consett
County Durham DH8 6SZ
U.K.

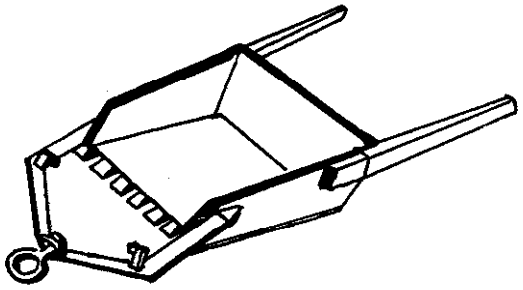
ANIMAL OR TRACTOR-DRAWN ROLLER
A large roller consisting of two cylinders, each with a diameter of 0.6m, a draw-bar and a seat.

It is available in two widths. The smaller size is 1.6m wide and weighs 223kg and the larger model is 2m wide and weighs 250kg.

ETS. TÉCHINÉ
82400 Valence d'Agen (T & G)
FRANCE

DAM SCOOPS

The following manufacturers produce dam scoops:



COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

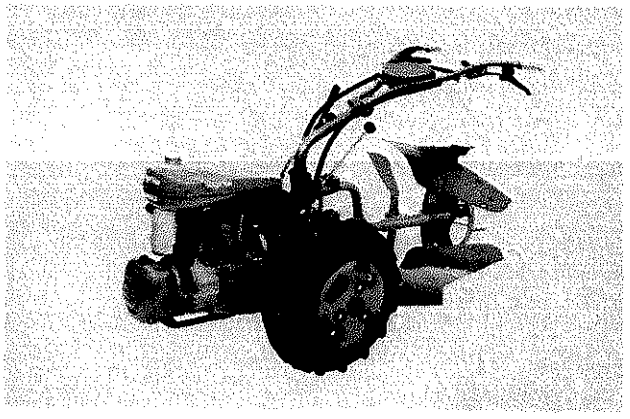
DANDEKAR BROTHERS
(Engineers & Founders)
Sangli — Shivaji Nagar, 416416
Maharashtra
INDIA

K.K. LIEN FABRIKK A/S
Tromøy, Arendal
4812 Kongshamn
NORWAY

RUMPSTAD B.V.
3243 ZG Stad Aan't-Haringvliet
Postbus 1
HOLLAND

BAIN MANUFACTURING COMPANY (PVT.) LTD.
Box 1180, Harare
ZIMBABWE

BROCKHOUSE (C.A.) LTD.
Box ST307, Southerton, Harare
ZIMBABWE



HEAVY-DUTY MULTIPURPOSE TILLERS

These heavy-duty tillers are designed to perform a wide range of tasks. They have two large tyred wheels and a variety of accessories which can be fitted for ploughing, weeding, mowing, transporting etc. Most of the manufacturers listed here and in the lightweight cultivation table on the previous page produce a range of heavy duty cultivators. A few are listed on this page.

TIGER
Technical Specifications:
Engine type: Diesel.
Power output: 10hp.
Gears: 9 speeds: 3 forward and 1 reverse in both running directions and 1 for road circulation.
Power take-off: Two; one of which is synchronized with all gears.
Attachments: Rotavator, trailer, plough, spray and irrigation pump, mower etc.
Four other models are available.

BARBIERI SpA
Via Circonvallazione, 19
36040 Sossano, Vicenza
ITALY

MODEL 2400
This model (illustrated above) has the following technical specifications:
Engine type: Diesel.
Power Output: 9hp.
Gears: 6 speeds: 3 forward, 3 reverse.
Power take-off: Independent.
Weight: 85kg (without attachments).
Tillage width: 5 widths: 32-65cm.
Attachments: Rotavators, ploughs, cutter bars, ridger, cultivator, harrow, trailer.
7 and 8hp models are also available.

AGRIA WERKE GmbH
Postfach 1147
7108 Möckmühl
W. GERMANY

REFORM 725
Technical specifications:
Engine type: Petrol, 4-stroke.
Power Output: 8hp.
Gears: 7 speeds: 5 forward, 2 reverse.
Power take-off: Independent.
Weight: 89kg.
Tillage width: 52cm.

REFORMWERKE BAUER & CO GmbH
P.O. Box 192
4600 Wels
AUSTRIA

BELIN POWER TILLER

This machine has a 4-stroke air cooled diesel engine with an oil regenerator and oil-bath air filter for hot climates.
Technical Specifications:
Engine type: Diesel.
Power output: 9-11-14 hp.
Gears: 9 speeds: 6 forward, 3 reverse.
Power take off: 3 P.T.O.s: 1 independent: 1 independent with clutch; 1 driving with rotavator.
Weight: 260kg.
Attachments: Rotavator, plough.

BELIN INTERNATIONAL
2 Mail des Charmilles, B.P. 194
10006 Troyes Cedex
FRANCE

REAPER CUM POWER TILLER

The prototype of the reaper cum power tiller has been adapted in Egypt from Chinese and Thai machines. It can be used for harvesting wheat, broad beans and berseem under demanding Egyptian field conditions. It is used during the labour-scarce period around harvest and therefore does not threaten employment.
Further information on tiller/harvesters is available in Section 7, Harvesting and Threshing machinery.

CATHOLIC RELIEF SERVICES
13 Ibrahim Neguib Street
Garden City, Cairo
EGYPT

TALPINA
Technical Specifications:
Engine type: Diesel.
Power output: 10hp.
Gears: 6 speeds: 3 forward, 3 reverse.
Power take-off: Two: one independent and one synchronized with the gear box.
Weight: 141-176kg.
Tillage width: 33-72cm.
Attachments: Rotavator, plough, lister, irrigation and sprinkling pump, trailer, seat, mower bar.
MAB also produce a smaller 10hp machine, and a larger 13hp model weighing 300kg.

MAB DI GUIDO BOCCHINI
Via Erbosa, 47030 Gatteo (FO)
ITALY

MOTORCULTIVATOR '92'
Technical Specifications:
Engine type: Diesel or Petrol, air cooled.
Power Output: 10hp.
Gears: 7 speeds: 4 forward and 3 reverse.
Power take-off: Two: One independent and one synchronized with all gears.
Weight: 120kg (without implements).
Attachments: Rotary hoe (Tillage width 45-60-75cm) multi-rotary hoe, ridger, ploughs, seat bogie, frontal cutter bars, frontal rotary grass mower, trailer.
Handlebars: Horizontal and vertical adjustment.
Five smaller models are available.

FERRARI, O.M. SPA
Via Valbrina 19, 42045 Luzzara (RE)
ITALY

STX 450
Technical Specifications:
Engine type: Petrol.
Displacement: 206cc.
Gears: 8 speeds: 6 forward, 2 reverse.
Attachments: Mower, scythe bar, trailer, ridger, hoe, tipping bucket, harrow.
There are 3 kinds of rotary tool: helicoid for normal ground, hoer for hard ground and standard for loose ground. The working widths are 40, 73 and 106cm.
There are 6 larger models with the following extra attachments available: rotary reaper, brushwood clearer, compost crusher, seeder, roller, log saw and bulldozer.

STAUB
54 rue Lambrechts, B.P. 316
92402 Courbevoie Cedex
FRANCE

MODEL DONG-FENG-12
Suitable for paddy fields, small dry fields, orchards and vegetable gardens.
Technical Specifications:
Engine type: Diesel.
Power Output: 12hp.
Gears: 8 speeds: 6 forward, 2 reverse.
Power take-off: Yes.
Weight: 340kg (without implements).
Attachments: Rotavator, plough, harrow, grass cutter, trailer and seat.
The tractor can also be used for small scale drainage and irrigation, spraying, grain threshing, cotton ginning, flour milling, fodder cutting etc.
This tractor is manufactured by the Chang Chow Tractor Factory. It is one of four models supplied by:

CHINA NATIONAL AGRICULTURAL MACHINERY IMPORT AND EXPORT CORPORATION
26 South Yeutan Street, Beijing
CHINA

PUMA 800
Technical Specifications:
Engine type: Petrol.
Displacement: 287cc.
Gears: 4 speeds: 3 forward, 1 reverse.
Power take-off: Yes.
Weight: 105kg.
Attachments: Rotavator, plough, wheel plough, 5-tine cultivator, harrow, grass cutter, drill (width 65cm), rotary scythe.
Also available is a heavier model, the Puma 900.

MOTOSTANDARD
13 rue Jean Mermoz, 71010 Mâcon
FRANCE

S.E.P. 1000
Technical Specifications:
Engine type: Diesel.
Power output: 7hp.
Gears: 3 speeds: 2 forward, 1 reverse.
Weight: 87kg.
Attachments: Rotavator (width 40-106cm), grass cutter, rotary mower, plough, furrower, irrigation pump.
S.E.P. produce a number of larger and smaller models.

S.E.P.
Fabbrica Macchine Agricole s.r.l.
42016 S. Martino in Rio (R.E)
ITALY

TITAN
The Titan is a 5hp single speed cultivator with reverse drive. It has a variety of cultivating rotors and row crop equipment for working tough, hard soil.
Technical Specifications:
Engine type: Petrol.
Power output: 5hp.
Gears: 1 forward, 1 reverse.
Weight: 80kg (including rotors).
Attachments: 3 types of cultivating rotor, weeder, furrower, coulter discs, side hoe and reversible plough. The working width is 94cm with 3 pairs of rotors fitted. Other models are available.

WOLSELEY WEBB LTD.
Edgemond Avenue, Tyburn,
Birmingham B24 OQX
U.K.

MODEL DT 120
A large and powerful tiller 2.4m in length and with a head lamp for working at night.
Technical Specifications:
Engine type: Diesel.
Power output: 8hp.
Gears: 8 speeds: 6 forward, 2 reverse.
Power take-off: 2.
Weight: 425kg.
Tilling width: 78cm.
Attachments: Rotary tiller with 15 blades. Plough with share length 22cm and width 25cm.
A more powerful model, the DT140, is also produced in Korea. It weighs 428kg and the engine has a continuous output of 10hp and maximum output of 14hp.
These models are manufactured by Tong Yang Moolsan Co. Ltd. and are available through:

KOREA TRADE PROMOTION CORPORATION
C.P.O. Box 1621, Seoul
KOREA

F800 ROTARY TILLER
The F800 is a tiller with a high power-to-weight ratio. It has adjustable handle bars and can be used with or without wheels. The wheel tracks are adjustable to suit varying row widths.
Technical Specifications:
Engine type: Petrol.
Power output: 7hp maximum.
Gears: 8 speeds: 6 forward, 2 reverse.
Power take-off: 2.
Dry weight: 110kg.
Tilling width: Up to 95cm.
Attachments: Slasher rotor, drum rotor, plough, weeder, ridger, dozer, 5-tine tool bar.
A 5hp model, the HONDA F600, is also available.

HONDA (U.K.) LTD.
Power Road, London W4 5YT
U.K.

WALKING TRACTOR MET-8
On a small area this mini tractor is economical and can be used for ploughing, harrowing, planting etc. The distance between the iron-gauge wheels can be adjusted from 425mm to 700mm.
Technical Specifications:
Engine type: Diesel.
Power output: 5hp.
Attachments: Plough, harrow, fixed-tine cultivator, etc.

MODERN ENGINEERING COMPANY
1A Anna Street, Velandi Palayam
Coimbatore 641 025, Tamil Nadu
INDIA

HAKORETTE 150

This cultivator has fully adjustable handle bars to enable the operator to walk to one side of the cultivated soil. It is powerful for its size and has a very wide range of cultivating widths. Used for paddy cultivation as well.
Technical specifications:
Engine type: Petrol, two stroke.
Power output: 6 hp.
Gears: 4 speeds: 3 forward, 1 reverse.
Tilling width: 18-120 cm.
Attachments: Rotavator, plough, cage wheels etc.

HAKO-WERKE
Hamburger Straße 209-239
Postfach 1444
2060 Bad Oldesloe
W. GERMANY

PASQUALI 900 SERIES

Pasquali produce a large range of cultivators and two-wheel tractors ranging from 8 to 26 hp. All are multi-purpose power units for which there is a large range of attachments.

PASQUALI SpA
Via Nuova 30
50041 Calenzano (Firenze)
ITALY

WALKING TRACTOR 306

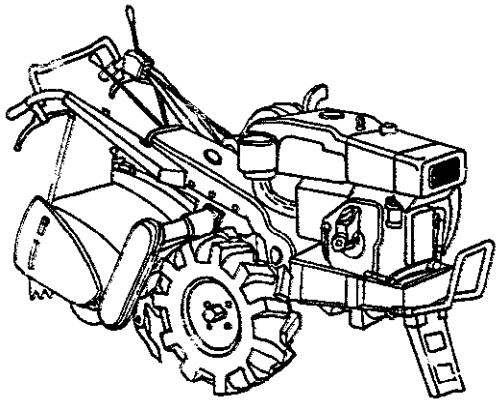
The special feature of this tractor is the 'quickfit' coupling for attachments which allows rapid change between a wide range of accessories powered through the PTO.
Technical specifications:
Engine type: Petrol 9-10 hp or Diesel 8 hp.
Gears: 4 speed: 3 forward, 1 reverse.
Tilling width: 26-65cm.

BERTOLINI MACCHINE AGRICOLE, SpA
42100 Reggio Emilia
Via Guicciardi
ITALY

REX COMBI

Available in two forms 'Universal' for general farm work and 'S' for slower cultivation work.
Technical specifications for 'S' model:
Engine type: Diesel 8 hp.
Gears: 4 speed: 3 forward, 1 reverse.
Weight: 190kg.

GORENJE MUTA
62366 Muta
YUGOSLAVIA



SINGLE-PURPOSE ROTARY CULTIVATORS

Designed specifically for heavy-duty rotavation, these power tillers are available with power outputs between 6 and 10hp; and tilling width between 40 and 70cm. The number of models produced is given in parentheses.

Tillers (illustrated left) manufactured by Kukje Machinery Co. Ltd., Dae Dong Ind. Co. Ltd. and Asia Ind. Co. are supplied by:

KOREA TRADE PROMOTION CORPORATION (9)
C.P.O. Box 1621, Seoul
KOREA

KERALA AGRO-MACHINERY CORP. LTD. (1)
P.O. Athani 683585
Ernakulam District, Kerala
INDIA

The Si Chuan 2 wheel Tractor Factory manufactures a tiller which is supplied by:

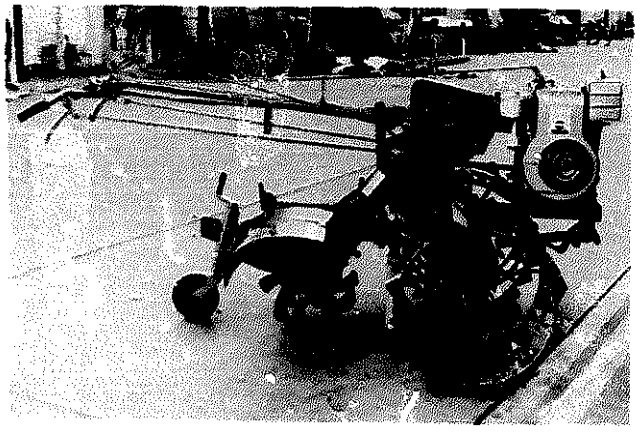
CHINA NATIONAL AGRICULTURAL MACHINERY IMPORT & EXPORT CORPORATION (1)
26, South Yeutan Street, Beijing
CHINA

KUBOTA (2)
2-47 Shikitsuhigashi 1-Chome
Naniwa-Ku, Osaka 556-91
JAPAN

MECHGARD LTD. (1)
Great Gransden, Sandy
Bedfordshire SG19 3AY
U.K.

GOLDONI SpA (5)
41012 Migliarina di Carpi, Modena
ITALY

SUZUE AGRICULTURAL MACHINERY CO. LTD. (11)
144-2 Gomen-cho
Nankoku-shi, Kochi-ken 783
JAPAN



IRRI WETLAND CULTIVATORS

Equipment designed by the International Rice Research Institute (IRRI) is produced by a number of manufacturers in India and South-East Asia. Particularly appropriate for wetland cultivation, the IRRI-designed implements are of a simple construction which enables them to be fabricated by small machine shops using widely available materials.

There are 2 IRRI-designed wetland cultivators currently available. The Rotary Tiller (top illustration) is a medium-powered walking tiller which may be used for both primary and secondary tillage. The power tiller (bottom illustration) has a slightly lower power output, but is equipped with a wider range of attachments which, in addition to standard tillage equipment include a 1m reaper. The Power Tiller may also be adapted for transportation work and as a power source for a water pump.

The Rotary and Power Tillers comprise a framework onto which the engine unit is mounted. This drives the (usually paddle-type) traction wheels and the rotary cultivator. They are equipped with 2 or 4 forward speeds which are controlled by variable centre distance pulley clutches. The roller chain drive transmission and rotary tiller drive housing are sealed in an oil bath and are designed to reduce the long-term maintenance costs.

Machine Specifications:
The Rotary Tiller
Power output: 6hp (diesel), 9hp (petrol).
Weight: 298kg (diesel), 257kg (petrol).
Number of tiller blades: 12.
Tillage width: 60cm.
Fuel consumption: 0.8 l/hr (diesel), 1.8 l/hr (petrol).

The Power Tiller
Power output: 3-4hp (petrol or kerosene).
Weight: 88kg.
Width (including paddle wheels): 129cm.
Fuel consumption: 1.1 l/hr (petrol).

Manufacturers of IRRI-designed Power and Rotary Tillers include the following:

B-J ENGINEERING & MACHINE WORKS
1238 Rizal St., San Jose
Baliwag, Bulacan
PHILIPPINES

BORJA MACHINE SHOP
Sgt. de Roma St.,
San Pablo City, Laguna
PHILIPPINES

GINTONG ANI METALWORKS
Cainta, Metro Manila
PHILIPPINES

ISAROG INDUSTRIES
826 Renacimiento St., Tabuco
Naga City, Camarines Sur
PHILIPPINES

JCCE INDUSTRIES
242 Mayondon
Los Baños, Laguna
PHILIPPINES

KASAGANAAN INDUSTRIES
San Jose, Mindoro Occidental
PHILIPPINES

KAUNLARAN INDUSTRIES
Calamba, Laguna
PHILIPPINES

MBP ENGINEERING
KM 16 MacArthur Highway
Malanday, Valenzuela
Metro Manila
PHILIPPINES

NIBROS MANUFACTURING CORP.
Dona Rosario Heights
Novaliches, Metro Manila
PHILIPPINES

POYING'S WELDING SHOP
262 National Hi-Way
Brgy. Anos, Los Baños, Laguna
PHILIPPINES

SABIO AGRICULTURAL EQUIPMENT
Magarao, Camarines Sur
PHILIPPINES

2M INDUSTRIAL COMPANY
San Mateo, Isabela
PHILIPPINES

A-1 ENTERPRISES
Luna St., La Paz
Iloilo City
PHILIPPINES

BETSY MARKETING
Huervana St., La Paz
Iloilo City
PHILIPPINES

VICMAC CORPORATION
Mandalagan, Bacolod City
Negros Occidental
PHILIPPINES

BUENACOSA, F. REPAIR SHOP
Tacurong, Sultan Kudarat
PHILIPPINES

FELICIANO AGRICULTURAL MACHINERY & WELDING SHOP
Midsayap, North Cotabato
PHILIPPINES

KABACAN ENGINEERING WORKS & SERVICES
Rizal Ave., Kabacan
N. Cotabato
PHILIPPINES

PETER LIM'S ENTERPRISES
San Francisco, Agusan del Sur
PHILIPPINES

ROSMAN MACHINE SHOP
Valencia, Bukidnon
PHILIPPINES

YOUNG'S METALCRAFT
Km. 3 Baan, Butuan City
PHILIPPINES

NATIONAL ENGINEERING CO. (MADRAS) PVT. LTD.
127 Angappa Naicken St.
Madras 600 001
INDIA

PHILIPPINE-MANUFACTURED HAND TRACTORS

After foreign-made land tractors had dominated the Philippines market during the late 1950's and early 1960's, locally-manufactured tractors began to be made on a small scale. This industry has grown very rapidly in recent years and there are now more than forty manufacturers of hand tractors in the Philippines.

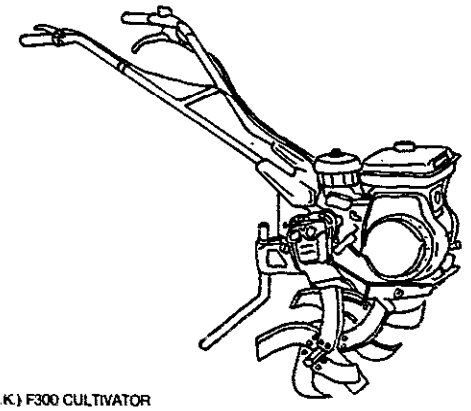
These tractors are continually undergoing design improvements to make them more suitable for conditions in the Philippines. Designed for medium and small-sized farms, they are constructed with the tractive axle drive located in front of the engine, or mid-way along the main body. The Philippine hand tractors (or power tillers) come in three categories: single axle, general, and double axle.

Single-axle power tillers: light-weight models with a 4 or 6hp petrol engine which can be adapted for a variety of agricultural operations by the attachment of conventional implements, (ploughs, harrows and cultivators). The general power tiller has reverse drive, multi-speed shifting transmission and a steering clutch.

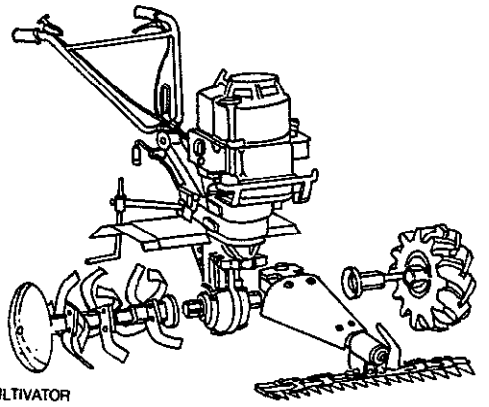
Double-axle power tillers: because the double-axle tillers have a larger engine and are sturdier, they are less versatile than the two smaller models. However, for the same reasons, they are well-suited to tilling heavy clay paddy fields. They have two driven wheels, and the tilling mechanism consists of a series of knives attached to a rotating shaft behind the main wheel axle. Double-axle tillers are usually equipped with a diesel engine of 6-14hp.

Information about them may be obtained from:

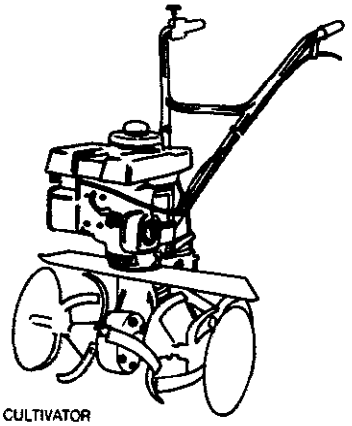
INSTITUTE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY
University of Philippines
Los Banos, College, Laguna 3720
PHILIPPINES



HONDA (U.K.) F300 CULTIVATOR



G.E.P. 35 CULTIVATOR



COURMONT SAM CULTIVATOR

LIGHT-WEIGHT CULTIVATORS

These cultivators are primarily designed for rotavating home or small market gardens, but interchangeable attachments may be provided for a range of other tasks. The area of land which can be cultivated is mainly determined by the size and power output of the cultivator.

The table below shows the main technical characteristics of typical machines from 20 manufacturers giving details of the motor and available attachments.

They are low power, walking machines mostly powered by a 2- or 4-stroke petrol engine with a power output of between 3 and 5hp. The gear box may provide more than one forward speed and up to two reverse speeds. Controls are mounted on the handlebar within easy reach. Most of the machines have detachable transmission wheels which are removed for rotary cultivation and replaced with the rotavator blades.

Coulter discs may be supplied for protecting plants from being covered with soil during inter-row cultivation. The table gives the range of working widths of the rotavator.

Apart from the rotavator, other attachments can be fitted such as rear-mounted ridgers, weeders or harrows and small trailers for transport.

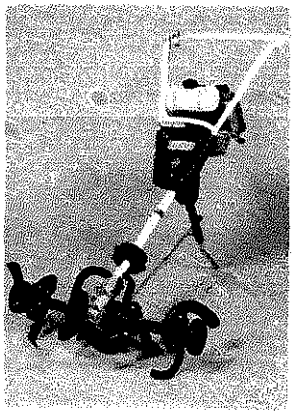
The table below shows a narrow selection of the range of manufacturers that exist in industrialized countries which produce lightweight cultivators. Those cultivators listed below are all of a similar type to those illustrated above and left.

There is another type of cultivator not featured in this guide (because it is less robust) in which the rotovator blades are placed in front of the motor, which is supported on two landwheels. These cultivators are very small.

NOTE: MOST OF THE MANUFACTURERS LISTED BELOW ALSO PRODUCE LARGER HEAVY-DUTY CULTIVATORS AND TWO-WHEEL TRACTORS.

Technical characteristics of typical light-weight cultivators

Manufacturer	Country	Model	2 or 4 stroke	Power output (or displacement)	Gears	Power take off	Weight (kg)	Maximum or range of working width (cm)	Traction wheels	Coulter discs	Rotavator	Ridger	Weeder	Trailer
Agria Werke	W. Germany	100-4	4	4hp	1	No	49	45-77	●	●	●			
Al-Ko	U.K.	Farmer 300 B	2	3hp	1	No	26	60			●			
Barbieri	Italy	Minizappa	2	4hp	2	No	42		●		●			●
Courmont	France	SAM	4	(161cc)	1	No		34-62		●	●	●		
Danarm	U.K.	TV 3	4	3	1	Yes			●	●	●	●	●	●
Ferrari	Italy	32 E	2	5hp	1	No	55	30-70	●	●	●			
Granja	France	GB 412	4	(127cc)	1	No		60		●	●			
Gutbrod Werke	W. Germany	MB 66-50	4	4.5hp	1	No				●	●			
Honda (U.K.)	U.K.	F400	4	3.5hp	6	Yes	45.5	95	●	●	●	●	●	●
Howard Alatpertanian	Malaysia	Stinger	2	3.5hp	1	No		61	●		●		●	●
Kanematsu-Gosho	Japan	MR7 4T	2	3.3hp	1	No	32	66.5			●	●	●	
M.A.B.	Italy	Formica 2T/4	2	4hp	1	Yes	50	40-60	●		●			●
Mason & Porter	New Zealand	Rotahoe	4	5hp	2	No	58	61			●			
Mechgard	U.K.	Terratiller	4		1	No			●		●	●	●	
Motostandard	France	MST60-32	4	(127cc)	2	No		60			●		●	
Ohashi	Japan	AR-551-651				Yes			●		●			
P.G.S.	Italy	MZ 503-505	2		1	No		40-80		●	●	●		
Charles Pugh	U.K.	Atco	4	3hp	2	No	50	60		●	●		●	
G.E.P.	Italy	S.E.P. 35	4	3.5hp	2	Yes	64	55-70	●	●	●	●	●	
Staub	France	ST 300	4	(148cc)	1	No	38	53		●	●	●	●	
Szegedi	Hungary	RK 02	4		1	No		34-60		●	●			
Wolseley Webb	U.K.	Super Major	4	3.5	2	No	44	94	●	●	●	●	●	

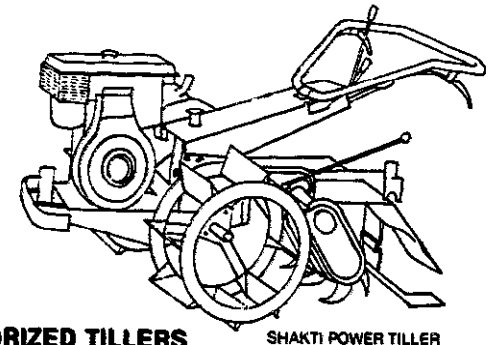


OTAKE MINI-CULTIVATOR, MA(MF)

The 'Otake' mini-cultivator is suited for use in both waterlogged or dry conditions. Developed from a Philippino prototype, the cultivator is powered by a 2-stroke, 50 c.c. engine generating a maximum of 2.2hp at 6,500 r.p.m. Its single forward gear has a reduction ratio of 1:35 which gives the rotor shaft a speed of 120-180 r.p.m.

The cultivator has a weight of 13kg (including engine and rotary tiller), and may be equipped with attachments for cultivating, puddling and furrowing in water-logged fields. For dry fields, additional equipment includes a weeder, ridger, hiller and fertilizer.

KANEMATSU-GOSHO LTD.
Central P.O. Box 103
Nagoyo 450-91
JAPAN



MOTORIZED TILLERS FOR WETLAND CULTIVATION

The following manufacturers all produce motorised tillers equipped with a wide range of accessories, including those necessary for rice cultivation.

NATIONAL POWER TILLER
Equipped with a 5hp diesel engine and 2 forward gears giving field and road speeds of 4.3 and 11.5km/h respectively. Field capacities vary from 0.5-0.8ha/8h-day for ploughing wet soil, to 2ha/8hr-day for puddling. The resulting average fuel consumption is 0.5 l/h. Total weight is 170kg.

The tiller can be fitted with a wide range of attachments which include: cage wheel, mouldboard plough, spiral and disc ploughs, spring-tine cultivator, comb harrow, ridger and leveller. It is also able to carry out transport, pumping and spraying operations.

NATIONAL ENGINEERING CO. (MADRAS) PVT. LTD.
127 Angappa Naicken St.
Madras 600 001
INDIA

MOTOCULTEUR BOUYER 1000
A similar design to the National Power Tiller, this model (illustrated above) is slightly heavier with a gross weight of 205kg. It is powered by a 12-15hp, 4 stroke, air-cooled diesel engine which is equipped with a rope starter and oil bath air filter. The transmission and gearbox is mounted in a cast iron housing and gives 6 forward speeds in 2 ranges and 3 reverse speeds. An independent 215 rpm power take off is fitted as standard. The Bouyer 1000 can be fitted with attachments for both wet and dryland cultivation. These include, for wetland, a plough, rotary cultivator, puddler and leveller. Additional accessories for dryland cultivation enable seeding, hoeing and ridging, mowing and scrub clearing, crop protection, irrigation, pumping and transport operations to be carried out.

BOUYER 'TR'
Also available is this two-wheel tractor specially designed for the tropics, with appropriate oil regenerator and oil bath air filter. Weight: 260kg. Motor: 9-14hp Diesel.

BOUYER
BP 7
54510 Tomblaine
FRANCE

SHAKTI POWER TILLER
Based on a similar model designed by Mitsubishi of Japan. The tiller is driven by a Model AD6V diesel engine with the following characteristics:
continuous output: 8hp, 1500 rpm.
compression ratio: 20:1.
fuel consumption: 245g/hp.h.

The tiller itself is of the side-drive rotary type, with a gross weight (including engine) of 393kg. The belt transmission and gearbox (6 forward and 2 reverse) give a maximum tilling speed of 3.6km/h and maximum road speed of 21km/h. The working width of the tiller is 54cm. Accessories available with this tiller are: depth-adjustable rotary cultivator, single mouldboard plough, leveller, ridger, 1.5 t capacity trailer.

In addition the tiller is equipped with a power-take off which may be adapted for pumping and processing operations.

V.S.T. TILLERS TRACTORS LTD.
No.1 Dyavasandra Industrial Layout
Whitefield Road, P.O. Box No.4801
Mahadevapura PO., Bangalore 560 048
INDIA

KRISHI DIESEL POWER TILLER, NV-700
A large (340kg), heavy-duty implement driven by a hopper-type, water-cooled diesel engine developing a 7hp output at 2200 r.p.m. The gear box and belt transmission give 4 forward and 2 reverse speeds. Each gear speed is suited to one or more functions to which the tiller may be adapted with available accessories.

1st gear gives a speed of 1.5km/h (1.1km/h, reverse) and is applied to tilling, puddling and ploughing in heavy soils.

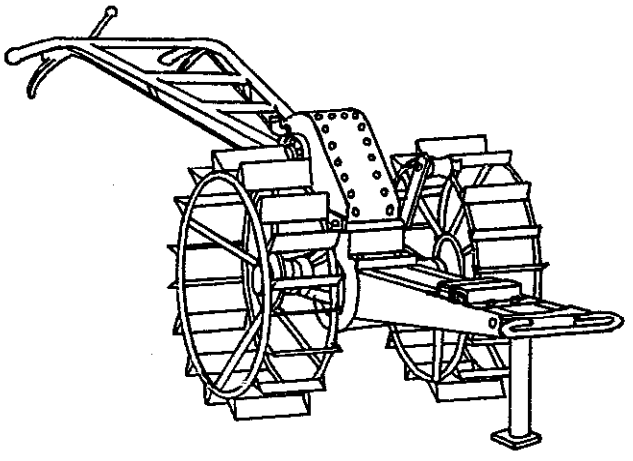
2nd gear gives a speed of 4km/h (4.8km/h, reverse) and is applied to ploughing, cultivating, ridging and seed/fertilizer drilling in normal conditions.

3rd gear gives a speed of 6.8km/h and is applied to crushing, seed/fertilizer drilling and transportation work.

4th gear gives a speed of 21km/h and is applied to transportation work.

Other accessories for water pumping, spraying, levelling and threshing are also available with this model.

KRISHI ENGINES LTD.
A-7 Unit, Sanatnagar
Hyderabad 500 018, A.P.
INDIA



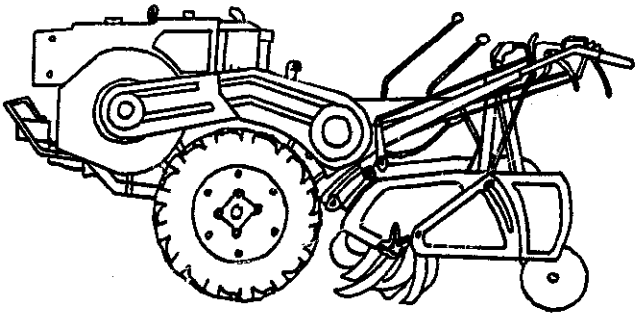
THAI-MANUFACTURED WALKING TRACTORS SUITABLE FOR WETLAND CULTIVATION

Designed by Thai manufacturers principally for a home market, these tillers, while able to work in dryland conditions, are also suitable for the cultivation of waterlogged rice fields. The tillers consist of an iron framework supported by 2 large paddle wheels. Wheels themselves are belt driven from a motor mounted towards the front of the frame (not illustrated). Attachments available for these tillers include a plough, ridger and harrow.

The paddle wheels serve as puddlers and may be detached and replaced with coulter discs. A range of plough shares are produced to suit differing soil conditions.

SAHA LIM TIE FACTORY
217/6 Mahachakpat Road
A. Muang, Chachoengsao
THAILAND

CHOK CHAROEN
724/5 Kor Po-thorg Road
A. Muang, Chonburi
THAILAND



MOTORIZED MULTI-PURPOSE TILLERS SUITABLE FOR WET/DRY LAND CULTIVATION

The machines described here are essentially similar to the all-purpose models listed on this page. They do however, have a more limited range of accessories and functions.

SUZUE POWER TILLER, MODEL C
A range of 3 heavy-duty tillers (c70, c90, c130). The c90 is equipped with a 10-12hp diesel engine, and has a gross weight of 340kg. It has an 8-speed gearbox (6 forward and 2 reverse) and a power take off, allowing such operations as pumping to be carried out. The tiller is fitted with a side-drive rotary cultivating unit (working width of 55cm), and additional accessories include a ridger, paddle wheel, riding seat and tail sled (illustrated above).

SUZUE AGRICULTURAL MACHINERY CO. LTD.
144-2 Gomen-cho
Nankoku-shi, Kochi-ken 783
JAPAN

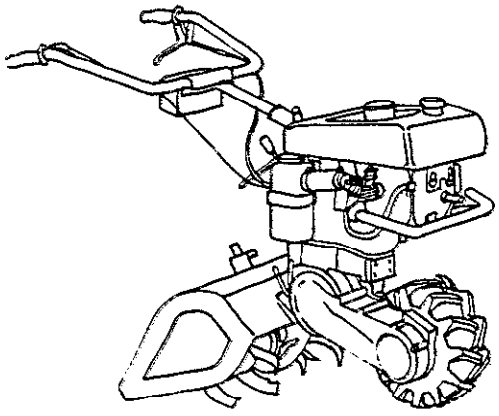
YANMAR POWER TILLER, MODEL YZC-10.5 DK
This tiller is driven by a 10.5hp diesel engine. It is principally used for wetland cultivation, and is available with ploughing wheels, swamp wheels and cage wheels.

Additional attachments include a rotary cultivator (standard), reversible plough, ridger and trailer.

YANMAR P.T. AGRI M/C
(P.T. YAMINDO)
42 Jl. Ir. H. Juanda
Jakarta, P.O. Box 4135/JKT
INDONESIA

KULIG-LIG POWER TILLER MODEL SK 160
A multi-purpose implement manufactured in the Philippines from locally available materials. Comprising 4 basic units — the mainframe, transmission, engine and handles — this tiller may be fitted with a disc plough, spiral plough, harrow, cage wheels and trailer. It takes either a 10hp petrol or 7-10hp diesel engine which will give a working speed of up to 4.7km/h. Working width is 43cm and maximum daily output is 1.6ha.

P.I. FARM PRODUCTS
Km 16, Malanday,
Valenzuela, Metro Manila
PHILIPPINES



MONO CULTIVATORS

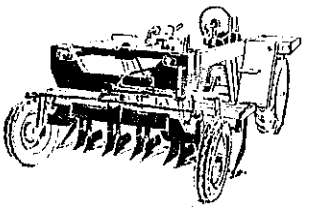
The manufacturers below make two models each of a single wheeled cultivator like the Barbieri 'Maxi fresa' (left). Barbieri also produce the 'Mini fresa'. These two models have a power of 8hp and 5hp respectively and a tilling width of 60cm. The Agria 3100 is made in a two-stroke or four-stroke version with power of 4 or 4.5hp. The Kaaz mono cultivators MA 100 and MA 130 distributed by Cosmo incorporated have power units of 2 and 3hp respectively with tilling widths up to 30cm.

The Barbieri models can pull a trailer.

AGRIA-WERKE GmbH, Postfach 1147
7108 Moeckmuehl, W. GERMANY

BARBIERI SpA
Via Circonvallazione, 19
36040 Sossano, Vicenza, ITALY

COSMO INCORPORATED
Towa Bldg 4th Floor
10,4 — Chome, Awaji-Machi
Higashi-Ku, Osaka, JAPAN



BEAVER TOOL CARRIER

The 'Beaver' is a self-propelled, four-wheeled tool carrier which can be used for drilling, hoeing, seeding, spraying etc. It has a single cylinder diesel engine which develops 14hp at 3500 rpm. An 18-24hp engine is also available. There are 2 forward and 2 reverse gears.

The multibar attachment is used for hoeing up to 12 rows (up to 50cm spacing). The depth and width can be adjusted. A 1m wide rotary cultivator and a 5 row inter-row rotary cultivator can be fitted. Other attachments available are seeders, sprayers for both row crop and overall boom spraying, rotary and cylinder grass cutters, 5 tine cultivators and a crumbler roll (illustrated above).

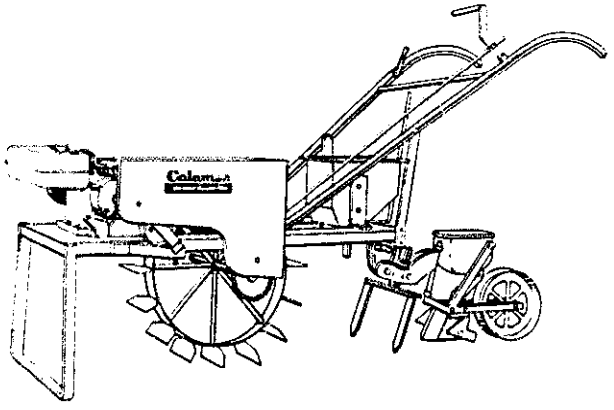
BEAN EQUIPMENT LTD.
Brays Lane, Ely
Cambridgeshire CB7 4QL
U.K.

IRON MULE

Coleman 'Iron Mule' is a well-balanced plough powered by a 3hp Briggs & Stratton engine with a 6 to 1 gear reduction and roller chain and sprocket drive to give more than 18hp pulling power.

With this plough you can break the ground when needed. The pulling power from the cleated wheel will pull this 15cm turn-plough 20cm in the ground. The single pulling wheel enables ploughing through the growing season. With the single wheel you can make sharp turns at the end of the row. The Coleman Garden Plough comes with the 30cm narrow for cultivating. Extra attachments are available such as a planter and fertilizer attachment (illustrated right). Further information on planters and fertilizer distributors is in Section 4.

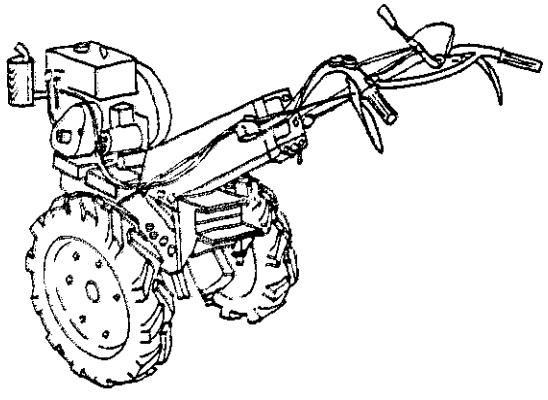
COLEMAN
Garden Plow Manufacturing Company
Route 8, Dothan, Alabama 36301, U.S.A.



MOUNTAINEER

The Model 88R is a walking tractor, 1.5m in length, which can be converted to a rider. It has a 1 cylinder, 8hp petrol engine. There are 8 forward ground speeds ranging from 0.8-8 k.p.h., 4 reverse speeds, and 2 Power Take Off speed ranges. The 88R weighs 190kg.

UNITED FARM TOOLS INC.
P.O. Box 9175
South Charleston WV25309
U.S.A.



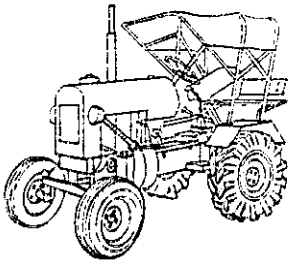
WALKING TRACTOR MODEL PHOENIX-4

The Phoenix-4 is a small 4hp, 2 wheeled tractor which can be fitted with various attachments. Technical Specifications:

Engine type: Diesel.
Rated Power output: 4hp.
Gears: 8 speeds: 6 forward, ranging from 3.74 to 15.5km/h, and 2 reverse: 2.74 and 3.48km/h.
Wheel tread (mm): 520, 580, 640, 700.
Ground clearance (mm): 300.

This tractor is manufactured by the Danyang Diesel Engine Works and is available through:

CHINA NATIONAL AGRICULTURAL MACHINERY
Import & Export Corporation
26 South Yeutan Street, Beijing
CHINA



RUSTOM MINI TRACTOR

Designed for small farmers, this tractor (illustrated above) is robust, easy to handle, and adaptable for ploughing, cultivating, hauling and running centrifugal pumps, threshers, crushers etc.

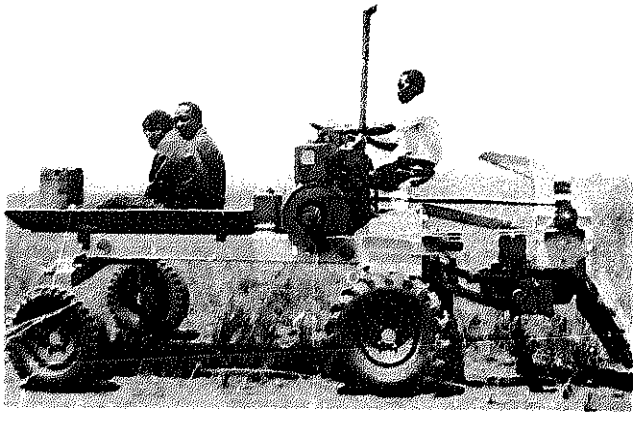
The engine is a single cylinder diesel engine with a rated output of 10hp and fuel consumption of about 1.5 l/h. It has a synchromesh gear box with 4 speeds — 3 forward and 1 reverse — and has a road speed of about 22km/h. The tractor is 2.7m long and weighs 1050kg. It is able to plough an acre in 1 to 1.5h and its hauling capacity is 2000kg. This small tractor is typical of many that are available worldwide.

RUSTOM TRACTORS
MANUFACTURING CO.
Delhi Road, Bahadurgarh 124507
Distt. Rohtak (Haryana)
INDIA

TINKABI TRACTOR

A four-wheel tractor with 20hp air cooled diesel engine and hydrostatic transmission, to control speed, direction of travel and braking by a single hand lever, no foot controls being fitted. It can travel up to a speed of 8km/h and has a drawbar pull of up to 818kg. It is 2.5km in length, with a fabricated chassis and integral oil reservoir and fuel tank. The engine and driver are at the rear, and in front of the driver is a load pan with a 500kg capacity. Implements include a plough, hammermill of capacity 180kg maizeih., planter, spring cultivator, ridger, harrow, circular saw, electrical generator, cotton sprayer, irrigation set, and a water pump capable of pumping 45,500 l/h and a transport trailer.

NATIONAL INDUSTRIAL
DEVELOPMENT CORPORATION OF SWAZILAND
Tinkabi Tractor Project
P.O. Box 450, Manzini, SWAZILAND



WESTWOOD GAZELLE

This small, four-wheeled tractor is 1.5m in length and has a forward-mounted engine for better balance and safety on slopes. Five models are available, ranging from 6hp to 16hp, and weighing from 130kg to 205kg. Each has 6 speeds; 5 forward and 1 reverse.

WESTWOOD ENGINEERING LTD.
Bell Close, Newnham Industrial Estate
Plympton, Devon
U.K.

2. INTERCULTIVATION

Intercultivation is concerned with the use of tools, implements and machinery to control weed growth and soil condition in the growing crop. The aim of intercultivation is to provide the best opportunity for the crop to establish itself after planting and to grow vigorously up to the time of harvesting. The term 'intercultivation' is sometimes used to describe methods of control which are not mechanical, as for example the use of herbicide chemicals, but here we are concerned only with the use of machinery and power for this purpose, i.e. mechanical weed control.

Intercultivation is a vital operation in most farming systems. The purpose of intercultivation is to:

- control the growth of weeds
- improve the potential condition of the soil by:
  - — reducing evaporation from the soil surface;
  - — improving infiltration of rainfall and surface water;
  - — reducing run-off of surface water and so reducing the severity of soil erosion;
- maintain ridges or mounds on which the crop is growing.

Of these purposes, control of weed growth is usually the primary objective.

Weeds compete with the growing crop for light, nutrients and water. Kline *et al* (1969) reported that weed growth and weeding is the major restriction limiting the area which a small-holder farmer can crop effectively; Curfs (1976) reports work showing that uncontrolled weed growth in upland rice results in a yield reduction of at least 50 per cent; work at Uyole Agricultural College in Tanzania (1974-75 season) indicated a similar reduction in yield due to weeds in maize.

Most work on weeding emphasizes the need for timeliness of weeding operations. This underlines the need for farmers to have operational control over power and machinery since timeliness in weeding is virtually

impossible if farmers rely on tractor work by a Tractor Hire Unit or contractor. They are only likely to achieve timeliness by using their own labour supply or their own animal power, possibly in close cooperation with a neighbour. The use of a small engine-driven single-axle tractor or rotary cultivator is an additional possibility but the cost of purchase and operation of such machines is generally high and they are ergonomically arduous to use in the field, particularly in tropical conditions.

Traditional farming systems, especially those associated with shifting cultivation, often make use of mixed cropping, sometimes with six or more different crops being grown on the same plot of land. In these cases it is difficult to distinguish between a tillage operation and a weeding operation. Mixed cropping can give effective weed control with little need for intercultivation. Traditional farming systems frequently use this fact to good effect and should not be changed without sound reasons.

Rowcrop planting was introduced to enable intercultivation to be done quickly and effectively using animal-drawn implements in monocrop systems. It is necessary in most cases to provide sufficient space between rows to provide a path for the draught animals and for an implement having a reasonable minimum width. The wide row spacing which results may encourage early weed growth. Accurate row spacing is essential for successful intercultivation. Rowcrops may not provide the best crop production system when human labour is the only source of power, particularly in hard soil conditions.

The selection of intercultivation equipment must therefore be looked at in the light of the overall farming system.

TECHNICAL CHARACTERISTICS

Human-powered

The main types of human-powered intercultivating equipment are:

- chopping hoes;
- pushing and/or pulling hoes;
- rotary hoes;
- wheeled push hoes and cultivators.

Chopping hoes are similar to the digging hoes described in Section 1 and indeed the majority of smallholder farmers possess only one hoe which they use as a multi-purpose implement. Section 1 should therefore be consulted when choosing a chopping hoe. The hoes may be short- or long-handled according to local custom, as influenced by soil conditions. Special-purpose chopping hoes are generally lighter than digging hoes. They may have tines rather than blades for working on the flat particularly in friable soils with rhizomatous weeds, so that a raking action may also be used.

Pushing and pulling hoes are used with a continuous action rather than the tiring intermittent strokes of a chopping hoe but are less suitable for hard soils, which they cannot easily penetrate. The blade is set at a sharper angle to the handle (about 55° to 65°, rather than 75° or so for a chopping hoe) so that the hoe blade is nearly horizontal (0° to 15° in work, as shown in Figure 1.

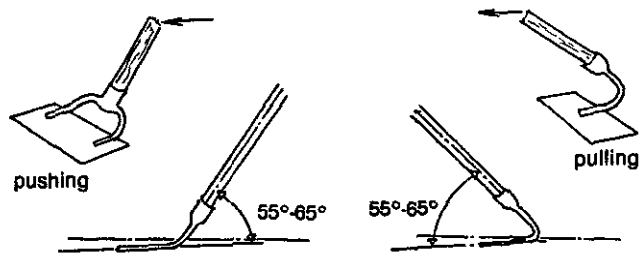
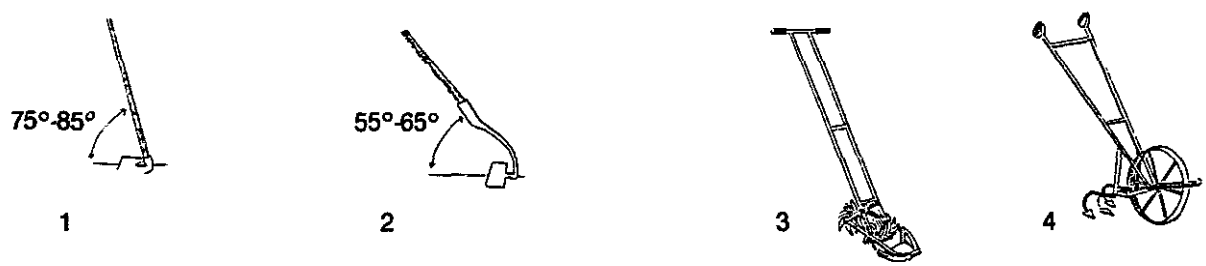


Fig.1 Pushing and pulling hoes, showing working angles.

Rotary hand weeders are particularly suited to weeding paddy rice planted in rows. The International Rice Research Institute in the Philippines (P.O. Box 933, Manila) has developed such a design which is suitable for local manufacture. Similar implements may be used

Table 1. Suitability of various types of hand-operated equipment for specified intercultivation conditions.

	Soil condition			*Soil topography*			*Cropping pattern*		
	Hard	*Friable*	*Plastic or muddy*	*Flat*	*Ridges*	*Mounds*	*Random*	*Rowcrop*	*decreasing "drudgery" increasing cost*
1. Chopping hoe	✓✓	✓	× ×	✓✓	✓✓	✓✓	✓✓	✓	
2. Pushing/pulling hoe	×	✓✓	×	✓✓	✓	×	✓	✓✓	
3. Rotary hoe/weeder	×	✓	✓✓	✓✓	✓	×	× ×	✓✓	
4. Wheeled hoe/cultivator	× ×	✓✓	✓	✓✓	✓	×	× ×	✓✓	



Key:
✓✓ equipment very well suited to the conditions specified.
✓ equipment moderately suited to the conditions specified.
× equipment unsuitable for the conditions specified.
× × equipment very unsuitable for the conditions specified.

for other crops grown on friable soils. In such cases the wheels are usually of peg or star-wheel form.

Wheeled push hoes and cultivators are available with a wide range of attachments — hoes, tines and mouldboards. They are particularly useful in friable loamy or sandy soils for crops such as vegetables grown in narrow rows.

Table 1 provides a guide to the suitability of human-powered equipment for a range of operating conditions.

Animal-powered

Animal-powered intercultivation equipment may be classified as:

- special purpose intercultivation implements;
- multi-purpose toolbars with a single small wheel for control and transport;
- multi-purpose toolbars with two supporting wheels or skids.

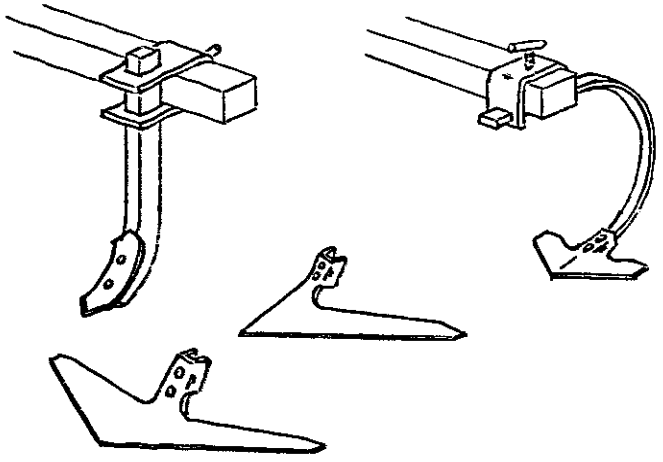


Fig.2 Tines and points: (top left) rigid tine with chisel point; (top right) spring tine with duckfoot point; (bottom) half and full sweeps for use with rigid tine.

Each type of implement is usually available with either rigid or spring tines to which may be fitted a variety of points, sweeps or mouldboards as shown in Figure 2. Chisel points (about 3 or 4cm wide) and duck-foot points (10cm to 15cm) are usually fitted to spring tines whose vibration assists in bringing weeds to the surface and breaking down soil clods as well as reducing the risk of damage if an obstruction is met. Sweeps (up to 50cm wide) and left- or right-hand half-sweeps must be fitted to rigid tines. They are intended to work a few centimetres under the soil surface detaching weeds at the roots and leaving the dried-up remains on the surface where they may act as a mulch to reduce evaporation and improve erosion resistance of the soil. Mouldboard ridging bodies may be used in weeding and restoring ridges for ridge-grown crops.

Special purpose intercultivation implements are usually fitted with a single small nose-wheel to assist in depth control and manoeuvrability at the headland. Toolbar frames may be adjustable in width, usually by a lever mechanism, to deal with a range of between-row spacings. Alternatively tines may be positioned on the frame to give the same effect. The special purpose cultivator is usually arranged to cultivate down the space between adjoining crop rows. Overhang of the frame at the sides beyond the outermost tines should be very small so as to avoid damage to the crops in the rows — the expandable type of cultivator has an advantage in this respect.

The straddle-cultivator which is listed in Section 3 of this guide is a special-purpose machine which may be used for intercultivation. It has the particular advantage that it may be used to cultivate the sides of ridges as well as being suitable for work on the flat.

Multi-purpose toolbars with a single small wheel or skid generally cost less than special-purpose implements since the same main toolbar frame is used, with various attachments for primary cultivation, seedbed preparation, intercultivation and, possibly, planting. The width of the main frame may sometimes be varied by bolt-on extensions to deal with a range of rowcrop spacings.

Multi-purpose animal-drawn toolbars are listed in Section 3 of the guide.

Multi-purpose toolbars with two supporting wheels are the most expensive of the forms of animal-drawn implements. They generally have two large wheels, a ride-on seat for the operator and a 'lift' mechanism (hand or foot-operated) to raise and lower the tines or other attachments when in use. The wheels are usually set at a track width of 1 metre to 1½ metres to suit the rowcrop spacing. When intercultivating the toolbar must generally pass over at least one row of the growing crop so that a good clearance height is necessary under the frame to which the tines are attached. This frame may sometimes be moveable from side to side to act as a 'steerage-hoe' under the control of an operator, making it easier to work close to the crop rows even if they have not been planted accurately in straight lines. Multi-purpose toolbars of this type are often used in conjunction with bed systems of cultivation.

These toolbars are listed in Section 3 of this guide.

Engine-powered cultivators

Single-axle engine-powered cultivators are listed in Section 1 of this guide. They may be used for inter-row cultivation when the soil is neither too dry nor too wet. The overall cost of operation per hectare will usually be higher than for other forms of cultivation equipment, including tractor-drawn implements. Engine-powered cultivators are also tiring to use, particularly in the tropics (Dibbits *et al*, 1978), so that their overall usefulness for intercultivation is limited.

Advantages

- Inter-plant weeding is essential in mono-crop production systems if reasonable yields are to be obtained consistently.
- Second and even third weedings often result in further improvement of yields sufficient to justify the additional labour and other costs.
- More sophisticated hand-operated equipment (moving from 1 to 4 in Table 1) reduces the work effort required, increases the rate of work and hence enables the farmer to increase the size of his holding, provided that equipment is well selected to meet particular circumstances.
- Animal-drawn equipment further reduces work effort and increases the rate of work. Rowcrop planting is then essential and between-row spacing must be accurate and consistent for best results.
- A single small animal, a donkey, for example, can pull a weeding implement in many conditions.

- Two-wheel animal-drawn multi-purpose toolbars have many advantages, but are relatively expensive. They are suited to broadbed and furrow systems which permit intercropping, reduce the tillage requirement and assist in moisture conservation (Bansal and Thierstein, 1982).

Alternatives

- Multiple cropping is particularly suited to small intensive family holdings operated with hand labour. Properly managed, the need for formal weeding operations may be virtually eliminated.
- Herbicide sprays may be used. Chemicals are relatively expensive. Environmental and health problems can be severe if strict control and management of chemical storage and spraying operations is not observed.
- Suitable 'cover-crops' may sometimes be available to stifle weed growth, particularly in tree crops.

Costs and Benefits

The benefits to be obtained from the use of intercultivation tools and machinery are:
- reduction of time required;
- reduction of human effort;
- possibly more effective operations.

The reductions of time and effort mean that it will be possible to improve crop care, resulting in better yields, or to crop an additional area of land assuming that there are no other operational bottlenecks.

Disadvantages to be offset against these benefits are:
- the need to plant in rows;
- the need for two distinct intercultivation operations:
  — between rows;
  — along the rows, i.e. between plants in the rows.

Compared to mixed cropping with random planting, rowcrop planting requires more time and care. The cost of a reliable machine for planting can be quite high and its effective use requires an attentive operator. The hand hoe, either a chopping hoe or a pushing/pulling hoe, are the only tools of those listed which can be used for along-the-row weeding. Along-the-row weeding is particularly necessary in the first weeding operation which is often combined with thinning to provide the plant spacing needed.

Data on work rates for various weeding implements is scarce and conflicting. Obviously there will be a wide variation depending on crop grown — which affects row spacing and plant spacing along the row — and also due to soil conditions, weed intensity and other factors. The effectiveness of the operation should also be taken into account.

For a crop such as maize in good soil conditions, typical work rates might be:
- hand hoeing between rows (chopping hoe): 100-150 man-hours/hectare;
- hand hoeing along rows combined with thinning: 50 man-hours/hectare;
- hoeing between rows with animal drawn hoe: 6-10 man-hours/hectare;

Costs of equipment vary widely from country to country and depend also on quality of materials and construction. Relative costs of good quality equipment when compared to a hand hoe are approximately:

pushing/pulling hoe	× 1.2
rotary hand-pushed weeder	× 6
wheeled hoe weeder	× 12
animal-drawn cultivator	× 15
animal-drawn toolbar (single small wheel)	× 20
two-wheeled animal drawn toolbar	× 80

In the last two cases the equipment cost must be shared with other operations such as ploughing and seeding for which the toolbar will also be used.

In addition to the cost of purchase, the operating cost must include the cost of the power input, whether human labour or animal power. These costs can vary widely.

Social impact

Mechanized farming systems usually have as their main objective an increase in labour productivity per unit of crop produced in order to improve economic viability. When this occurs other benefits accrue, such as relief from drudgery and an increase in the skills and status of the farmer. An increase in labour productivity implies a reduction of the labour force required and hence an increase in unemployment. Often however, mechanization is a response to an existing shortage of labour or to a requirement to bring more land into cultivation. In these cases there is no reason why unemployment should be significantly increased.

Taking a broader view, even if labour were displaced from the farm, mechanization provides an opportunity to develop the manufacturing activities of the country by producing the required machinery inputs. Service industries involved with sales and repair are also necessary so that mechanization has a part to play in providing wider employment opportunities which are productive and satisfying in their nature.

Special considerations

Materials Soil-engaging parts — blades and forks for hoes, points of tined cultivators, toothed wheels of rotary weeders — must be made from high carbon steel, which can be hardened and tempered as needed, if the sharpness of the tool is to be maintained and fast wear is to be avoided. Frames of animal drawn implements must also be manufactured from high grade steel if they are to be of necessary strength whilst maintaining light weight. Handles of long-handled hoes should be made from straight grained, light, tough and resilient wood as available (Hopfen, 1969).

Adjustment Working parts of implements are usually bolted to tines to allow replacement when worn. Nuts and bolts should be avoided wherever possible for other fittings and adjustments. Clamps tightened by tommy bars rather than spanners are to be preferred — spanners, nuts and bolts are easily lost and the hexagon heads of nuts and bolts are easily damaged.

Rowcrop systems

- The speed and effectiveness of intercultivation in rowcrop systems is very much influenced by the care taken with previous operations — in particular the accuracy of row planting and the consistent preparation and levelling of the seedbed, or the accuracy of ridge formation.
- Rowcrop spacing may be varied from traditional practice to suit new cultivation systems and machinery, the plant population being maintained by adjusting the in-the-row plant spacing.

Table 2. Pull and power of various animals in good condition

Animal	*Typical weight: kg*			*Pull-weight ratio*		*Typical speed*	*Typical power*
	Light	*Average*	*Heavy*	*Low*	*High*	*km/h*	*kW*
Ox	250	350-600	700	0.10	0.12	3	0.40
Cow	220	300-500	600	0.08	0.10	2½	0.30
Buffalo	400	500-700	800	0.12	0.14	3	0.60
Donkey	120	150-200	250	0.14	0.20	3½	0.25

Notes:
1. The lower value of pull-weight ratio should be used when walking conditions are poor (i.e. rough or soft ground). The higher value may be used when conditions are good.
2. The pull-weight ratio is based on the continuous capability of the animal over a working period of three to four hours.

Draught animal power (DAP)

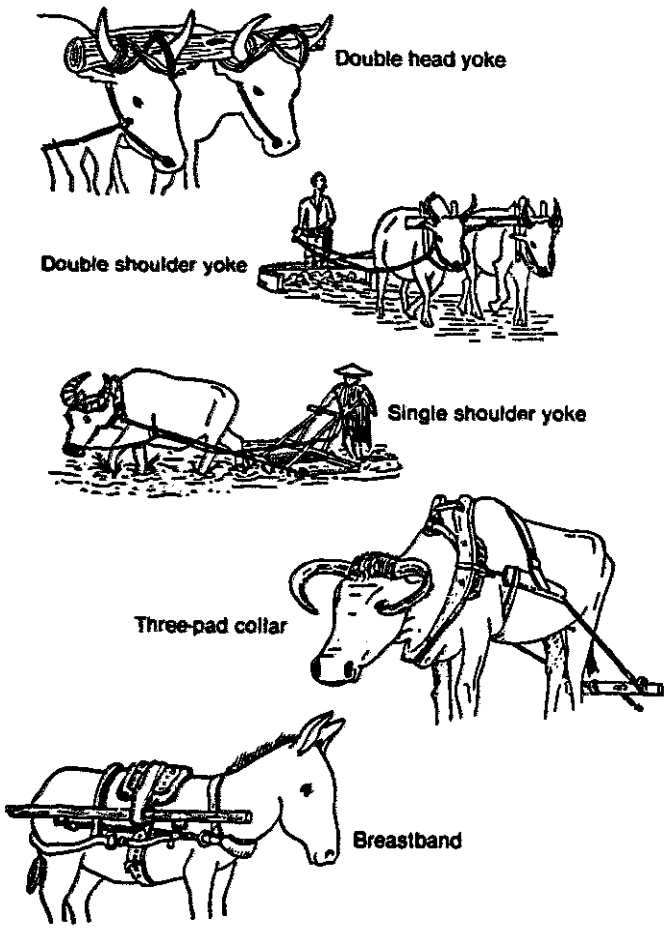


Fig.3 Types of Harness.

- DAP has been used for many thousands of years to provide power for intercultivation and other field operations, transport, water lifting and processing operations. The most-used species are cattle (approximately 60 per cent of the total world number of work animals), buffaloes (15 per cent) and donkeys (10 per cent).
- Within each species, for animals in good condition, the draught capability depends mainly on the weight of the animal and to a rather lesser extent on the breed. Table 2 shows typical pull capabilities of the three main species. For example, a 450 kg bullock should, taking a pull-weight ratio of 0.12, be capable of providing a pull of about 0.12 × 450 kgf = 54 kgf (540 newtons).
- Full benefits of the animal power will not be realized if it is only used for primary cultivation and seedbed preparation. Attention should also be given to applying draught animal power to planting, weeding, harvesting and transport operations.
- The introduction of animal-drawn equipment may benefit from a radical review of existing practice (such as the possibility of introducing a broadbed and furrow system with a two-wheeled toolbar) backed up by realistic evaluation trials.
- The full benefits of animal-powered mechanization are only likely to be realized if the farmer has operational control of their use. This implies the ownership of at least one draught animal, and the encouragement of mixed farming systems.

Animal harnesses

Many types of harness are in use throughout the world. Although types vary in detail they may be classified as:
- yokes:head yoke (sometimes called neck yoke);
  shoulder yoke (sometimes called neck yoke or withers yoke);
- collar;
- breastband.

These harnesses are illustrated in Figure 3.

The most effective type of harness depends on the species and breed of animal. Yokes are suitable for bovines — cattle and buffalo — which in general have strong shoulders, whilst the equines — horses, donkeys and mules — produce their best pull from the breast. The yoke is therefore unsuitable for equines, who should be fitted with collar or breastband harness.

Yokes may be used for single animals or to harness animals together in pairs. The head yoke is not suitable for humped Zebu cattle (*bos indicus*) which in general

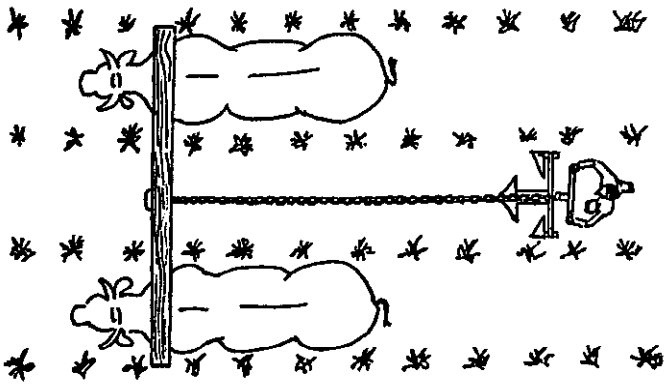


Fig.4 Top view of a long beam yoke for cultivation between rows, showing the animals spaced at twice the row width.

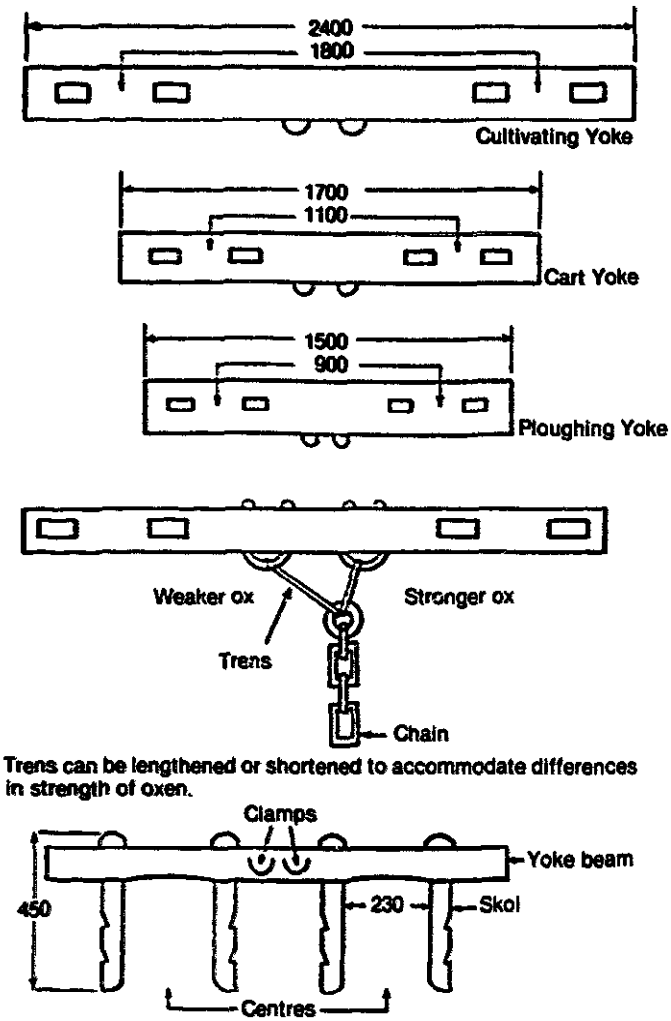


Fig.5 Double neck-yokes used in Southern Africa (row crop spacing: 900mm) (Howard, C.R. 1979 'The draft ox: management and uses' *Zimbabwe Rhodesia Agric. J.*, Vol 77(1).)

have weak necks compared to non-humped (*bos taurus*) types. The double shoulder yoke is usually simple in shape and construction, and so is easy to make. It has however been criticized for its tendency to cause shoulder sores and to compress the trachea and the blood vessels entering the chest and causing the animal to tire quickly. These shortcomings can be alleviated by shaping the yoke carefully to fit individual animals and providing padding at contact points.

Double yokes are most commonly used but single yokes may also be used in conjunction with a *swingle-tree* enabling the implement to be pulled directly behind the animal. A single animal is usually well capable of pulling an intercultivation implement in light to moderate soil conditions and extends the possibility of ownership and use to a greater number of farmers who are unable to invest in a pair of oxen.

The double yoke beam has to be longer for intercultivation work compared to ploughing because the animals have to straddle two rows of crops to work the space between them. The spacing of the animals then corresponds to twice the row width as shown in Figure 4. Figure 5 (Howard, 1979) gives the dimensions of double shoulder yokes used in Zimbabwe for a row-width of 90cm.

Professor Frank Inns
Silsoe College

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Kline, C.K., Green, D.A.G., Donahue, R.L. and Stout, B.A. 1969. *Agricultural Mechanization in equatorial Africa. Michigan State University; Research Report No. 6.*

Munzinger, P. 1982. *Animal traction in Africa.* GTZ Eschborn, F.R. of Germany.

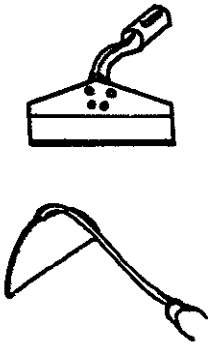
WEEDING HOES

The 10 hoe types illustrated below cover a range of implements designed for removing weeds from cultivated plots. They are ideally suited for weeding post-emergence either between or within the rows. There are two major types in this category, those that chop the weeds and the soil, and those that cut the weeds below the surface in a pushing and pulling action. In addition to these hoes there are another 8 hoe types illustrated on page 38. Manufacturers listed there are indicated on the table below, with a dot in the 'other' column.

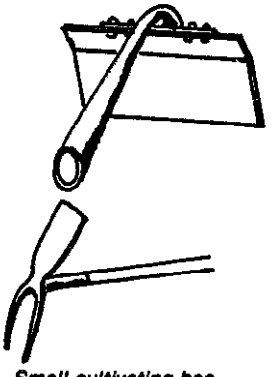
Flat hoe
WILHELM ABT

Weeding hoe
WILHELM ABT

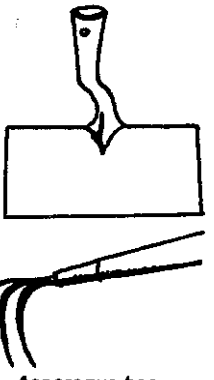
Pulling hoe
LANG FERRY



Pushing hoe
LANG FERRY



Dutch hoe
BURGON & BALL



Dutch hoe
ELKEM A/S

Onion hoe
BURGON & BALL

Small garden hoe
WILHELM ABT

Small cultivating hoe
WILHELM ABT

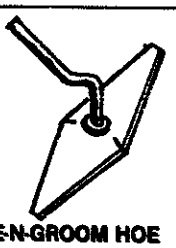
Asparagus hoe
WILHELM ABT

Manufacturer	*Country*											*Other*
BORAL CYCLONE LTD.	Australia		●					●		●	●	●
BULLDOG TOOLS	United Kingdom			●	●		●					●
BURGON & BALL LTD.	United Kingdom	●					●				●	
CALDWELLS LTD.	United Kingdom				●							
CEAF, S.N.C.	Italy				●					●	●	●
LÉON CLÉMENT & CIE	France	●			●	●	●			●	●	●
COSMO INCORPORATED	Japan	●	●								●	
COSSUL & CO. PVT. LTD.	India											●
DALTON COOPER & GATES CORP	U.S.A.											●
EDELMIRO VAZQUEZ HNO.	Spain									●		
EICHER GOODEARTH LTD.	India									●		
ELKEM A/S	Norway		●					●				●
FARM MACHINERY RESEARCH CENTRE	Sri Lanka							●				●
FORGES DE LAVIEU S.A.	France	●			●	●				●		
GOSERUD PRODUCTS MFG. CO.	U.S.A.			●					●			●
GOVERNMENT IMPLEMENT FACTORY	India									●	●	
IDEALSPATEN UND SCHAUFELWALZWERK GmbH	West Germany				●							●
JENKS & CATTELL LTD.	United Kingdom				●		●	●			●	●
KELLER MFG. CO. INC.	U.S.A.				●							
KOREA TRADE PROMOTION CORP.	Korea		●								●	
KUMAON NURSERY	India									●	●	
LANG FERRY & CIE	France	●	●	●	●	●	●				●	●
LYSBRO FABRIKER A-S	Denmark	●		●				●			●	
MANUFACTURE FRANÇAISE DE FOURCHES	France		●	●	●	●	●	●	●	●	●	●
NORBERGS, ATS SPAD & REDSKAPSFABRIKER	Sweden	●	●					●			●	●
OUTILS WOLF	France	●						●		●	●	●
SAMUEL PARKES & CO. LTD.	United Kingdom	●					●		●	●	●	●
POLAR WERKE GmbH	West Germany			●	●			●		●	●	●
SANDVIK AB	Sweden		●							●		
S.I.C.F.O.	France							●		●	●	●
A. SPALDING & SON LTD.	United Kingdom	●										
SPEAR & JACKSON (TOOLS) LTD.	United Kingdom			●		●	●		●		●	
SYNDICAT DE L'OUTILLAGE AGRICOLE ET HORTICOLE	France	●									●	
TRAMONTINA SA	Brazil									●		
TROJAN PTY. LTD.	Australia	●					●			●	●	●
WELISARA AGRICULTURAL IMPLEMENT COMPANY	Sri Lanka		●					●				●
WILHELM ABT GmbH & CO KG.	West Germany	●	●	●						●	●	
WILKINSON SWORD LTD.	United Kingdom				●		●					
WOLF TOOLS FOR GARDEN & LAWN LTD.	United Kingdom	●						●		●	●	●
WÜRTT GABELFABRIK FR. KRAUTER KG	West Germany	●	●							●	●	
ZINCK'S FABRIKER A/S	Denmark					●	●	●			●	

SHARMA HAND HOE

This hoe manufactured in 3 widths by Cossul has 3 cutting edges. Suitable for heavily weed-infested plots. Similar models made by FMRC and Welisara. Capacity is about 0.05 ha/h.

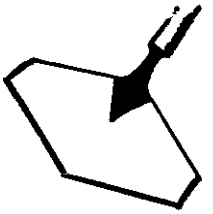
COSSUL, INDIA
FMRC, SRI LANKA
WELISARA, SRI LANKA



GLIDE-N-GROOM HOE

Goserud produce this hoe which is operated by a push and pull motion, cutting weeds below the surface. Blade 16cm wide. Similar models are produced by the other manufacturers listed below.

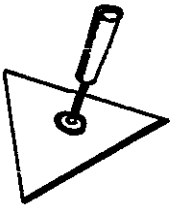
GOSERUD, U.S.A.
LEON CLEMENT, FRANCE
MANUFACTURE FRANÇAISE DE FOURCHES, FRANCE
LANG FERRY, FRANCE
SIFCO, FRANCE



TANGED PAXTON HOE

Bulldog produce the hoe in 2 sizes 152mm and 200mm width. The finish is half bright and is shaped on the two front faces. It is fitted with a 1.5m handle. Similar models are produced by Jenks & Cattell and Polar Spaten.

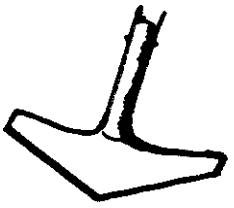
BULLDOG, U.K.
JENKS & CATTELL, U.K.
POLAR WERKE, W. GERMANY



TURNIP HOE

This hoe from Elkem Spigerverket is 70mm wide with a 137cm handle. It weighs 0.8kg. Similar hoes are produced by Norbergs, Parkes and Trojan.

ELKEM SPIGERVERKET, NORWAY
NORBERGS AB, NORWAY
PARKES, U.K.
TROJAN, AUSTRALIA



PUSH-AND-PULL HOE

Cyclone produce this hoe used for cutting weeds below the soil surface. The blade width is 175mm and the handle is 1330mm long.

The standard pack for all of Cyclone's hoes (and also their mattocks and picks) contains six implements.

BORAL CYCLONE, AUSTRALIA

SPINTILLER

This 'revolutionary' implement's pairs of blades are set at about 12° to the vertical so that they converge in a slide-slicing and rotary chopping motion which cuts into the ground in a digging, pinching action. A 2-tine head is also available.

BULLDOG, U.K.
DALTON, COOPER & GATES, U.S.A.
IDEALSPATEN, W. GERMANY
OUTILS WOLF, FRANCE
WOLF, U.K.

CHAVROT EMANCHE

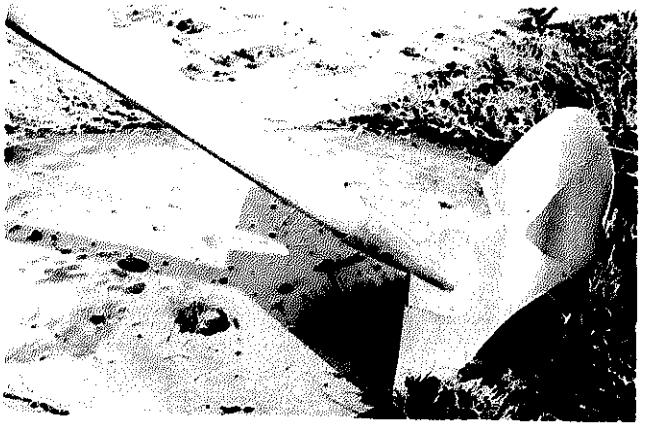
Léon Clément produce this swan-necked hoe in two sizes weighing 1000g, for the small model, and 1100g for the large model. A similar hoe is produced by CEAF.

LEON CLEMENT, FRANCE
CEAF, ITALY

METZ NANCY

Léon Clément produce this forged swan-necked hoe. It is available in 3 widths (of 3 differing weights) 140mm (0.4kg), 160mm (0.5kg), 180mm (0.6kg). Also available is the broader, 260mm (0.8kg) 'Chapeau de Gendarme' hoe, a broad blade with a raised, rounded centre to which the neck is attached.

LEON CLEMENT, FRANCE



MULTIHOE

The Multihoe is a cleverly designed new tool which can perform many soil-moving tasks in vegetable gardens. Additionally it has a lock recess on its upper edge which enables it to cut thicker weed stems. Among the tasks it can perform are:

HOEING Draw it backwards and forwards to use the bottom cutting edge and point.

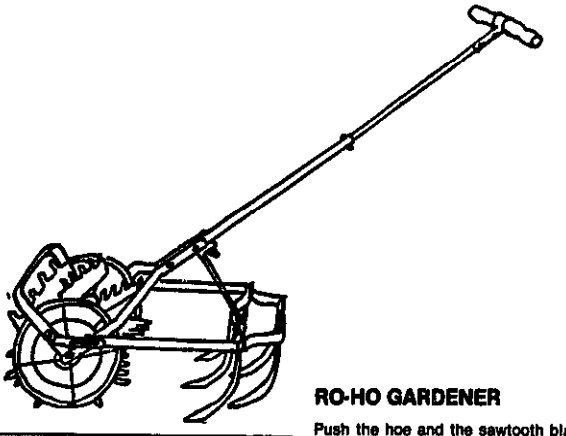
WEEDING Use the lock recess to cut plant stalks.

EARTHING & TRENCHING Use the Multihoe's plough shape to create a smooth rounded trench, or for earthing-up.

SEEDING & PLANTING Draw the hoe through the soil to create a seed drill, or lift and strike the point down to make deep holes for planting.

Available in 5 sizes with short (15cm) or long handles.

MULTIHOE GARDEN TOOLS
Hayne Barton
Stowford, Lewdown
Devon EX20 4BZ
U.K.



RO-HO GARDENER

Push the hoe and the sawtooth blades bite into the soil and leave a pulverized mulch. The sharpened scuffle blade cuts off the weeds, and permits work close to the plants even when small. Reverse the hoe and it is ready for deep cultivation. The hoe is completely adjustable. Not recommended for stony or trashy soil.

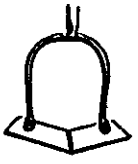
Various models in sizes up to 35cm wide available from:

ROWE ENTERPRISES INC.
Galesburg
IL 61401
U.S.A.

DALTON COOPER AND GATES CORP.
205 West 34th Street
New York, NY 10001
U.S.A.

AMERICAN LAWN MOWER CO.
P.O. Box 369
Shelbyville, IN 46176
U.S.A.

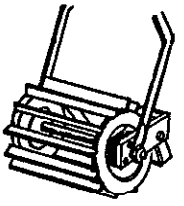
MAHARASHTRA AGRO IND. DEV. CORPORATION LTD.
Rajan House, 3rd Floor
Near Century Bazar, Prabhadevi
Bombay 400 025
INDIA



LINCOLNSHIRE LONGHORN HOE

The main feature is a pair of Long Bull Horn handles, which give a remarkable degree of control and leverage, and which meet in a single main shaft and split again into a wide-angled blade. It comes with two sets of blades, the single blade for between rows and the double to span a row of crops. Weight: 3.3kg.

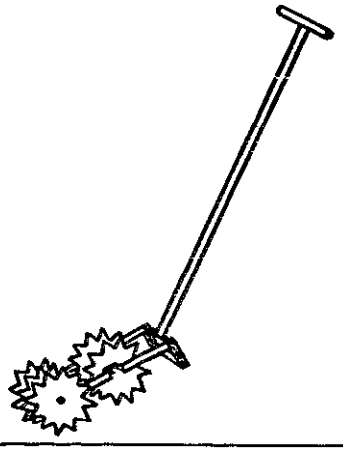
PALMER & SHELLEY LTD.
Nechells Place
Birmingham B7 5AL, U.K.



HOEBOY

Designed to rotavate prepared soil, remove weeds, and keep soil free from weeds through the growing season. 12 revolving blades break up surface soil, to form air-filled mulch, ideal for bacteria to work in. The cutting knife at the rear cuts weed roots below the surface. Width: 21cm, net weight: 4.5kg.

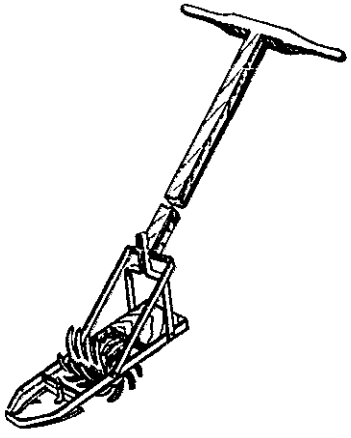
TRADEWINDS INC.
Box 1191-F, Tacoma,
Washington 98401, U.S.A.



STAR WEEDER

The star weeder is used for the intercultivation of row crops such as vegetables, groundnuts, jowar etc. It is only suitable for dryland farming. The star-shaped cutting edges chop weeds and rake the topsoil, creating good mulching conditions. There are three blades at the front, and two at the rear. This implement can cover 0.2ha per day, and according to the manufacturers, is almost 50 per cent more cost-efficient for weeding than the hand kurpi. The star weeder can also be worked across the rows to contribute to earthing operations.

ANDHRA PRADESH AGRICULTURAL UNIVERSITY
Rajendranagar
Hyderabad 500 030
INDIA



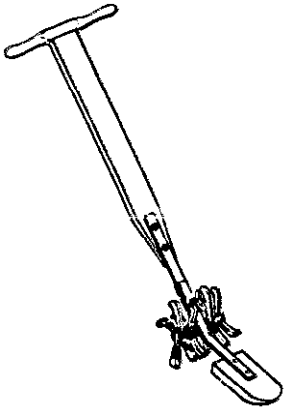
SINGLE-ROW ROTARY PADDY WEEDERS (SINGLE CYLINDER)

WELISARA ROTARY WEEDER This all-steel, manual weeder is suitable for medium lowland soils and has a capacity of 0.029 ha/h. It has a working width of 140mm and a working depth of 50mm.

WELISARA AGRICULTURAL IMPLEMENT COMPANY
Welisara, Ragama
SRI LANKA

MALANG SINGLE-ROW WEEDER Similar in design to the model above but has a capacity of only 0.012 ha/h, and has a working width of 110mm and a working depth of 70mm.

U.D. BLIMBING
Malang
INDONESIA

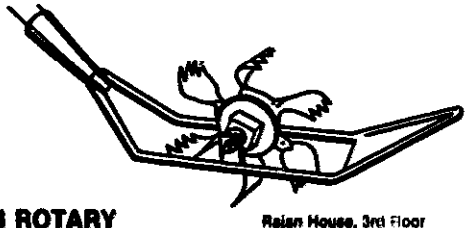


SINGLE-ROW LOWLAND ROTARY PADDY WEEDER

This weeder is produced by both the Farm Machinery Research Centre and Welisara. It consists of a T-bar handle which is fixed to the rear of the bracket. Steel rotors are attached to the single axle which passes through the bracket. A float is fitted at the front. The weeder is suitable for lowland paddy and for medium puddled soil. It weighs about 2kg, and has a working width of 150mm and a working depth of 60mm. It has a capacity of 0.028 ha/h.

FARM MACHINERY RESEARCH CENTRE
Maha Illupallama
SRI LANKA

WELISARA AGRICULTURAL IMPLEMENT COMPANY
Welisara, Ragama
SRI LANKA



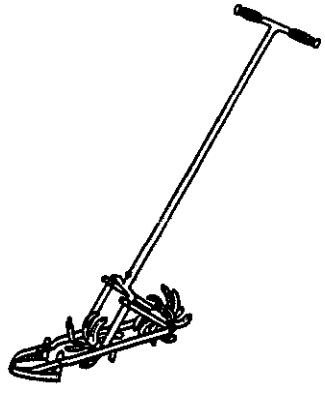
INDIAN ROTARY PADDY WEEDERS

ROTARY PADDY WEEDER The head of this weeder can be adjusted to the required cultivation angle, and the height of the handle is adjustable. It consists of six serrated, spoon-shaped blades which are welded to a drum. (Illustrated above).

MAHARASHTRA AGRO IND. DEV. CORPORATION LTD.
Rajan House, 3rd Floor
Near Century Bazar, Prabhadevi
Bombay 400 025
INDIA

INDIAN ROTARY WEEDER This is a similar model to the above, and has a capacity of 0.025 ha/h. Working depth: 50mm; width: 80mm.

WELISARA AGRICULTURAL COMPANY
Welisara, Ragama
SRI LANKA



SINGLE ROW ROTARY PADDY WEEDERS (DOUBLE CYLINDER)

These weeders are similar in design to the single cylinder paddy weeders featured above, except that they consist of two spiked cylinders, which are fixed one behind the other in the frame, increasing the efficiency of the weeding process. Manufacturers of this type of weeder include:

AKSHAT AK-53 AND AK-55 WEEDERS These two weeders have respective working widths of 150mm and 90mm. AK-55 illustrated above.

AMERICAN SPRING & PRESSING WORKS PVT. LTD.
P.O. Box 7602
Adarsh Housing Society Road
Malad, Bombay 400 064
INDIA

PADDY WEEDER This weeder is very similar in design to the Akshat models described above.

WEST BENGAL AGRO-INDUSTRIES CORPORATION LTD.
23B Netaji Subhas Road
3rd Floor
Calcutta 700 001
INDIA

ROTARY PADDY WEEDER Welisara and the Farm Machinery Research Centre both manufacture this weeder, which has a working width of 150mm and a capacity of 0.028ha/h.

FARM MACHINERY RESEARCH CENTRE
Maha Illupallama
SRI LANKA

WELISARA AGRICULTURAL IMPLEMENT COMPANY
Welisara, Ragama
SRI LANKA

IRRI PUSH-TYPE HAND WEEDER Developed by the International Rice Research Institute, this weeder includes a front skid made of light sheet metal which serves as a depth control. It has a capacity of 35-75 man h/ha, and a width of 150mm.

POYING'S WELDING SHOP
262 National Hi-Way
Brgy, Anos, Los Banos
Laguna
PHILIPPINES

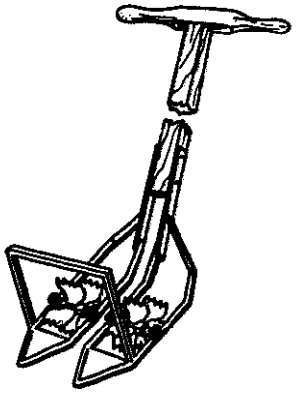
ALPHA MACHINERY & ENGINEERING CORP.
Makati Commercial Center
P.O. Box 579
Makati, Metro Manila, D708
PHILIPPINES

PADDY WEEDER This all-steel weeder is best used on fields where 25-50mm of water is standing. It has a capacity of 0.3ha per day.

COSSUL & CO. PVT. LTD.
123/367-Industrial Area
Eazalgunj, Kanpur, U.P.
INDIA

WEEDER Similar to the above weeders in design, this model has a working depth of 130mm.

MUSUHAMA, C.V.
Jl. Raya Kajen 248
Tegal, Jawa
INDONESIA

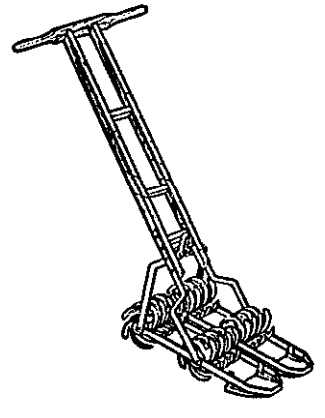


TWO-ROW INDIAN ROTARY PADDY WEEDER

Produced by both the Farm Machinery Research Centre, and Welisara, this Indian rotary paddy weeder is similar in principle to the single-row model above. It consists however of a double frame which is bracketed firmly to the wooden handle, and stabilised by a cross-bar in front. Two sets of serrated blades rotate on twin drums fitted to two independent axles. This weeder is suitable for light soils, and has a capacity of 0.03ha/h. It has a working width of 280mm and a working depth of 50mm.

FARM MACHINERY RESEARCH CENTRE
Maha Illupallama
SRI LANKA

WELISARA AGRICULTURAL IMPLEMENT COMPANY
Welisara, Ragama
SRI LANKA



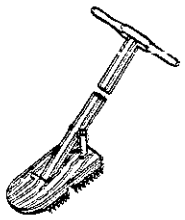
DOUBLE-ROW ROTARY PADDY WEEDERS (DOUBLE CYLINDER)

HAND PADDY FIELD WEEDER Cecoco produce a 2-row as well as a single-row weeder. The sled and claw wheels are aluminium sheet. It is available in three sizes, with working widths of 2 × 180mm, 2 × 210mm, and 2 × 240mm.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

TWO-ROW ROTARY WEEDER Designed for wetland puddled soils, it has a sturdy wooden handle and a capacity of 0.04ha/h. Working depth is 75mm and working width is 240mm. The weeder has two floats, one for each row.

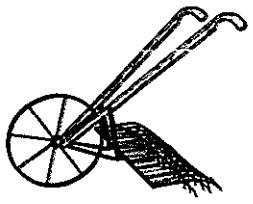
WELISARA AGRICULTURAL IMPLEMENT COMPANY
Welisara, Ragama
SRI LANKA



NAIL WEEDER

The nail weeder is suitable for paddy in light soils. It is operated by one man, who will be able to cover a hectare in about 50 hours. Overall length: 1.2m.

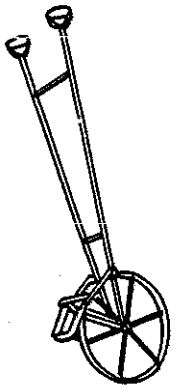
WELISARA AGRICULTURAL IMPLEMENT COMPANY
Welisara, Ragama
SRI LANKA



WIRE WEEDER

As well as weeding, this tool can break up the soil surface, or rake grass and leaves. It is 1.2m wide, with the wires 19mm apart. The weeder alone (less handles and wheel) can be bought for use on a wheel hoe.

DALTON COOPER AND GATES CORP.
205 West 34th Street
New York, NY 10001
U.S.A.

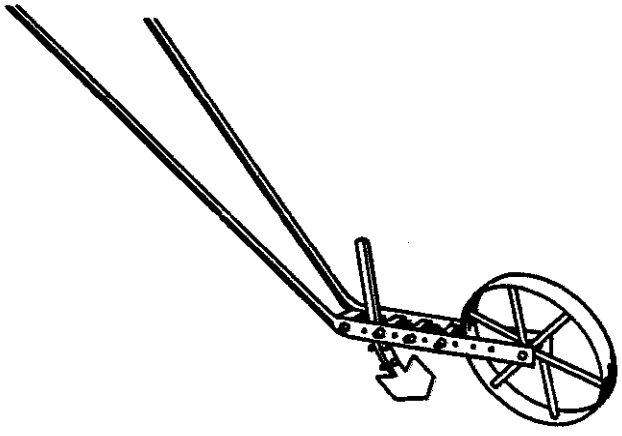


HAND WHEEL-HOES

The hand wheel-hoes manufactured by Union Forgings and Tropic (illustrated left) are designed for the efficient intercultivation of row crops by one operator. Weeds are cut by the action of the rear-mounted blade passing through the soil. The operator pushes and pulls this blade whilst standing in one place, before moving along the row. They are easy to operate and require little effort. The Union Forgings model differs in having right-angle bent handles instead of D-shaped handles, and a V-shaped blade.

UNION FORGINGS
Focal Point
Sherpur, Ludhiana
Punjab
INDIA

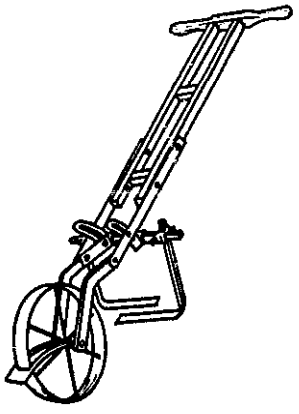
TROPIC
B.P. 706, Douala
CAMEROUN



HAND WHEEL HOE

This implement consists of a wheel, a frame and a hoe. It works on the same principle as the Tropic and Union Forgings hoes described above. The major difference however, is the V-shaped tine which cuts the weeds and, at the same time, moves earth to right and left to form small ridges on either side of it. Thus it also performs an earthing operation. The hoe is 150mm wide and 150mm long. The fixed height of the whole implement is 950mm.

MAHARASHTRA AGRO IND. DEV. CORPORATION
Rajan House, 3rd Floor
Near Century Bazar, Prabhadevi
Bombay 400 025
INDIA



WHEEL HOE

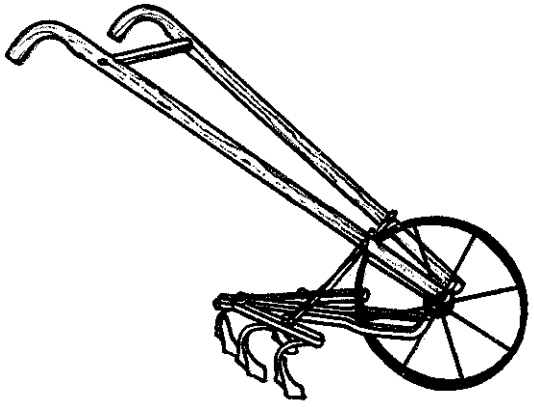
Two horizontal cutting blades, each 185mm long, are fixed to a horizontal bar (see illustration). By altering their positions, a maximum cutting width of 370mm can be obtained. The maximum depth that the blades can be used at is 30mm.

The horizontal bar can take a variety of other soil-working components, the height and position of which can be adjusted. In the case of tines, the maximum depth is 60mm. With appropriate attachments, the device is suitable for any upland crop, in light to medium soils.

The height of the handle bar is 975mm, and the overall weight is 12kg.

WELISARA AGRICULTURAL IMPLEMENT COMPANY
Welisara, Ragama
SRI LANKA

FARM MACHINERY RESEARCH CENTRE
Maha Illupallama
SRI LANKA



'FARMER' CULTIVATOR, PLANET JR. NO. 125

The 5 reversible cultivator teeth perform a hoeing action. They are arranged so that the furrow made by the outside tooth next to the row is filled up by the following tooth. The teeth are the right width for thorough cultivation and easy pushing and have double life because they are reversible. All are made of oil-hardened, tempered steel.

This model is quickly adjustable in width from 24cm to 38cm, which means cultivation of 30 to 61cm rows at one passage. For still narrower rows, the two outside teeth can be easily removed. The 46cm diameter, steel wheel is adjustable to regulate the depth of work and the handles are adjustable in height to suit the operator. The overall weight of the cultivator is 11kg.

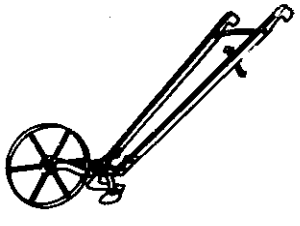
DALTON COOPER AND GATES CORP.
205 West 34th Street
New York, NY 10001
U.S.A.

HAND-PUSHED CULTIVATOR

This is a very versatile multipurpose toolbar type of hoe. The frame is of metal. It has an overall length of 1.52m and a chassis width of 0.30m, and the handle is held 0.61-0.91m above the ground. It has a weight of 6.4kg. It can be used with one wheel (for cultivating between crop rows) or two wheels (for cultivating both sides of a single crop row).

The following attachments are available: a 20cm V-shaped skimmer for hoeing in soil with no stones; pulverising star-shaped rotating blades for breaking up soil; rakes for seed-bed preparation; 'duckfoot' cultivators for aeration and prevention of weeds; and a ridger for root crops.

JALO ENGINEERING LTD.
Wimborne Industrial Estate
Mill Lane, Wimborne
Dorset
U.K.



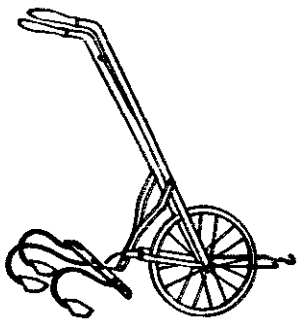
ONE WHEEL HOES

ONE WHEEL HOE — 'RADANA' Removal of weeds and loosening of soil crusts is achieved by this type of cutting blade (illustrated above). The wheel can be adjusted by means of screws in the forks for height and depth. The blade is designed to be used even in the hardest ground. The wheel has bearings on both sides for durability. The cutting tools consist of 2 cutting blades, 19cm long, and a goosefoot plough, 10cm wide, which is adustable up, down and sideways. It is possible to fit an attachment for heaping up the soil.

TRÖSTER LANDMASCHINENFABRIK GmbH & Co. Kg
P.O. Box 240, 6308 Butzbach
W. GERMANY

HIGH-HOE The High Hoe is strongly constructed yet light and easy to use. It has two horizontal blades which can be adjusted by simply undoing two wing-nuts, and placing them in numerous different positions for either centre or side hoeing. The handles can be adjusted to 3 different heights for ease of use.

HIGHLIGHT ENGINEERING CO. LTD.
Highlight Engineering Works
Dunnington, Yorkshire YO1 5LP
U.K.



HAND WHEEL HOES

Various manufacturers of different types of wheeled hoes are listed below.

'MACO' WHEEL HAND HOE Using this model (illustrated), one person can hoe 0.4ha in a day.

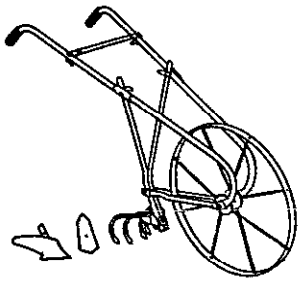
MOHINDER & CO. ALLIED INDUSTRIES
Kurali, Distt. Ropar, Punjab
INDIA

'HIRA' WHEEL HAND HOE 0.4ha can be hoed in 1 day. Width of cut: 5-30cm. Depth of cut: 2.5-6.4cm. Weight with all attachments: 13kg.

INTERNATIONAL MFG. CO. (Regd.)
Hospital Road, Jagraon
Ludhiana, Punjab
INDIA

LOW WHEEL GARDEN PLOW, MODEL 210, 3 shovels, a mouldboard ploughshare and a 5-prong cultivator attachment are available for this model.

DOMINION MANUFACTURING CO.
Bridgewater, Virginia
U.S.A.



LARGE WHEEL HAND-HOES

The following manufacturers produce various types of large wheel hoe with a variety of attachments including 3- and 5-tine cultivators.

MODELS 501A and 1501A BIG WHEEL CULTIVATOR

AMERICAN LAWN MOWER CO.
P.O. Box 369
Shelbyville, IN 46176
U.S.A.

HIGH WHEEL CULTIVATOR 243A

LAMBERT CORP.
519 Hunter Avenue
P.O. Box 66, Dayton, OH 45404
U.S.A.

HIGH WHEEL GARDEN PLOW 220

DOMINION, CO.
Bridgewater, Virginia
U.S.A.

WHEEL HOE

COSSUL & CO. PVT. LTD.
122/367-Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

HAND CULTIVATORS

These models of hand hoe are all similarly constructed. A metal frame extends backwards from each end of the axle. Onto the rear of the frame are placed two handles (their angle can be adjusted) and a variety of implements for ploughing, ridging, cultivating and earthing-up.

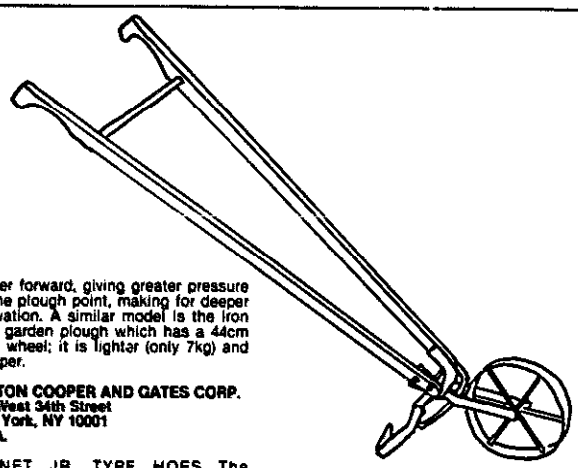
HAND CULTIVATOR NO. 85 The cultivator (illustrated above) is of light steel construction with wooden handles, about 12kg in weight, and comes with the following soil-engaging parts: 2 weed cutters, 5 cultivator tines, garden plough and furrower.

K.K. LIEN FABRIKK A/S
Tromby, Arendal
4812 Kongshamn
NORWAY

THILOT ONE-WHEELED HOE This model is especially designed for very narrow row widths. Cultivating width is 25cm at maximum. The bearings are dust-proof, minimizing maintenance. Gross weight with two flat weeder cultivators, 3 tines, a plough and spanner is 6kg.

PHYCO B.V.
Postbox 79
Leusden-G, 3830 AB
NETHERLANDS

PLANET JR SINGLE WHEEL HOES Nos. 16, 17, 17½, 18 and 19 single wheel hoes are different variations on a two-handled 37cm diameter steel-wheeled hoe. The first four models come with a variety of implements, a different set for each model, as a standard: plough, cultivator, weeder, flat tines, rakes and spanner. Additional attachments include a 5-prong weeder, pulverizer, a pair of 3-pronged cultivator teeth, onion harvester (a flat V-shaped blade) and a 20cm goosefoot weeder. The latter is ideally used in combination with the pulverizer mounted to its rear. The weight of these hoes is around 10kg inclusive of attachments. No. 19 hoe (garden plough) is of a more rugged construction with the handles placed further forward, giving greater pressure on the plough point, making for deeper cultivation. A similar model is the Iron King garden plough which has a 44cm steel wheel; it is lighter (only 7kg) and cheaper.



DALTON COOPER AND GATES CORP.
205 West 34th Street
New York, NY 10001
U.S.A.

PLANET JR. TYPE HOES The manufacturers below make hoes very similar to the traditional Planet Junior hoes described above.

COSSUL & CO. PVT. LTD.
123/367-Industrial Area,
Fazalgunj, Kanpur, U.P.
INDIA

KUMAON NURSERY
Ramnagar 244715
Nainital, U.P.
INDIA

APS-51 ASPEE HOE American Spring make this hoe with 20cm flat weeder tines, 3 cultivator tines, plough and spanner. The hoe has stainless steel handles with rubber grips. Weight 7.5kg.

AMERICAN SPRING & PRESSING WORKS PVT. LTD.
P.O. Box 7602
Adarsh Housing Society Road
Malad, Bombay 400 064
INDIA

HAND-WHEEL HOE This hoe has a narrower base plate to which are attached three cultivator tines. It has steel handles and is designed for dry field operation.

WEST BENGAL AGRO-INDUSTRIES CORPORATION LTD.
23B Netaji Subhas Road
3rd Floor, Calcutta 700 001
INDIA

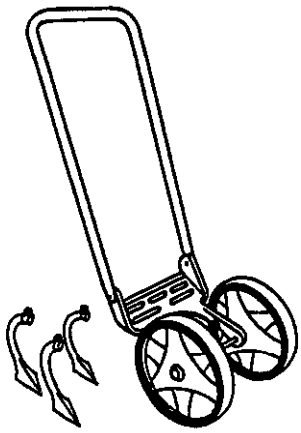
JUPITER WHEEL HOE This is a sophisticated single-wheel hoe. It has a spoked, semi-pneumatic, rubber-tyred steel wheel (30cm diameter) mounted on ball bearings. The light-weight handles have pistol-grip ends. Standard attachments are available plus a 22cm oscillating stirrup (a continuous flat hoe blade) which makes minimum effort push-pull cultivating possible. Alternative arrangment consists of two 15cm or 30cm stirrups which, with an offset wheel axle, allows close cultivation each side of a crop.

DALTON COOPER AND GATES CORP.
205 West 34th Street
New York, NY 10001
U.S.A.

CULT-A-EZE GARDEN CULTIVATOR

Supplied with 3 tools: a 5-tine cultivator for hoeing, a slicing hoe with a horizontal blade and a furrow plough. These just slot into place, with no wrenches needed. An optional mouldboard/hilling plough is also available. Weight including attachments is 6kg.

EARTHWAY PRODUCTS INC.
P.O. Box 547, Maple Street
Bristol, IN 46507
U.S.A.



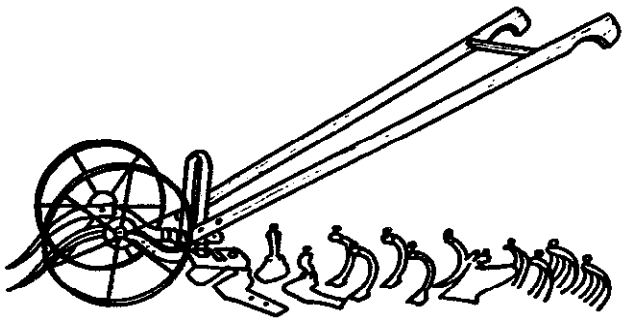
TWO-WHEELED HAND HOES

GARDEN HOE This is an all-metal cultivator with a handle which is adjustable in height. The following attachments are available: cultivators (hoes), rakes, rotary pulverizers, a lawn aerator, a plough, a skimmer and a ridger.

JYOTI LTD.
Bombay Shopping Centre
R.C. Dutt Road, Vadodara 390 005
INDIA

TWO-WHEELED HAND WEEDING MACHINE The use of one or two large wheels makes this cultivator versatile. The tools available are cultivators (hoes), horizontal blade hoes and ploughs. The net weight with accessories is 7kg.

PHYCO B.V.
Postbox 79, Leusden-G, 3830 AB
NETHERLANDS



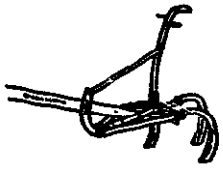
COMBINED DOUBLE AND SINGLE WHEEL HOE

This adaptable cultivator can be used with one wheel or with two — 102 to 279mm apart. The frame height can be adjusted so that it can straddle a row of plants 50cm high. The wheels are made of steel and are 356mm in diameter. The frame is light, unbreakable pressed steel, and the handles are adjustable in height.

Attachments are all oil-tempered. Using the two 114mm and two 152mm hoes, rows from 15 to 51cm apart can be intercultivated. Leaf-lifters, rakes and ploughs are also available.

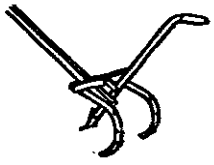
There are 3 models; the Planet Jr nos. 11, 12 and 13. The no. 11 has all the attachments, the no. 12 all but the 114mm hoes and the rakes, and the no. 13 only the pair of 152mm hoes.

DALTON COOPER AND GATES CORP.
205 West 34th Street
New York, NY 10001
U.S.A.



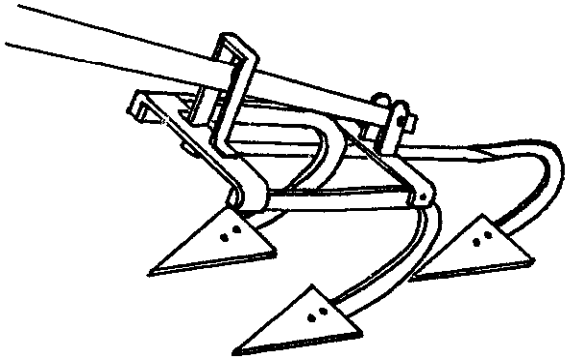
COSSUL 3-TINE ANIMAL-DRAWN CULTIVATORS

R.N. CULTIVATOR This is a steel cultivator with a long wooden beam and a single handle. The shovels are made of high carbon steel and are reversible. The width can be adjusted very easily through holes provided in the frame. The depth can also be adjusted by changing the height of the beam through holes provided for that purpose. Mouldboard plough, ridger plough and seeding fertilizer attachments can be supplied. The R.N. Cultivator can cover 1.2-1.6ha per day. Illustrated above.



VIKAS JR. CULTIVATOR The Vikas Jr. is a simpler version of the R.N. Cultivator above. The width of the 3 tines is easily adjustable. A mouldboard plough, seeding attachments, and sweeps of various sizes can be supplied. The area covered by the Vikas Jr. is 1.2-1.6ha per day.

COSSUL & CO. PVT. LTD.
123/387-Industrial Area
Fazalguni, Kanpur, U.P.
INDIA



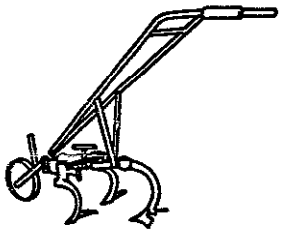
'TRIPHALI' 3-TINE CULTIVATORS

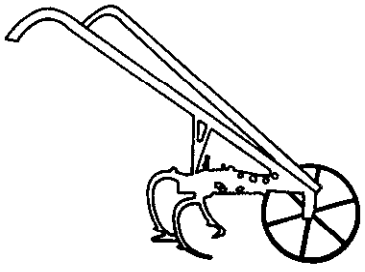
MACO ADJUSTABLE TRIPHALI This bullock-driven cultivator (illustrated) is designed for tilling after ploughing, and for preparing the seedbed for moisture conservation. It can also be used for intercultivation. Using one pair of bullocks, the 'Triphali' can cover 1.2ha per day. It has a working width of 45-60cm, and a working depth of 5-10cm.

MOHINDER & CO. ALLIED INDUSTRIES
Kurali, Distt. Ropar, Punjab
INDIA

TRIPHALI Union Forgings produce a 3-tine cultivator similar to the model above. It is designed for secondary cultivation, but can be used for hoeing widely spaced crops. It is also useful for weeding in loose soils and for breaking the crust formed after rain.

UNION FORGINGS
Focal Point, Sherpur
Ludhiana, Punjab
INDIA



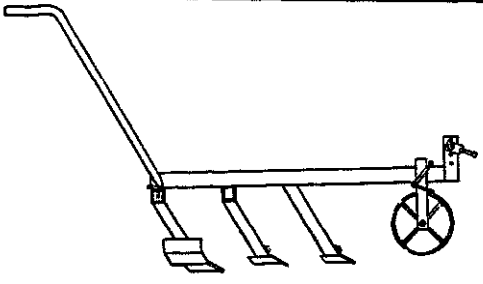


3-TINE CULTIVATORS

AC-3 CULTIVATOR This model (illustrated above left) is made from iron, with steel blades. The space between the blades is easily adjusted by loosening a bolt, without having to change the direction of the blades. The blade direction can however be adjusted for different types of work if necessary. The cultivator is available with various attachments for weeding, hilling, ridging or furrowing. It has a capacity of 4-5 ha/h and a working width of 250-350mm. The net weight of the cultivator is 17kg.

ANIMAL DRAUGHT CULTIVATOR The working width of this cultivator (illustrated above right) can be easily adjusted and the blades remain parallel at all width settings. The implement has a net weight of 21kg and a capacity of 4-5ha/h.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN



5-TINE WEEDER

This is a weeder designed for use with maize and sunflower. It is of box-section construction, which reduces the weight, as do the pipe handles. It has a 20cm diameter plough wheel. The tines are attached with 25 x 12.5mm bolts, and the width is adjustable. The weeder incorporates outside ridging tines for throwing soil against the buttress roots of the plants, as well as spring, steel-tipped, and duck-foot tines for weeding.

LUGARI EXTENSION PROGRAM
Appropriate Implements Project
P.O. Box 125, Soy
KENYA

'INKUNZI' BS3 CULTIVATOR

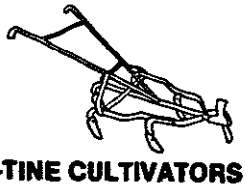
This is a 3-tine cultivator with land wheel. It consists of one long beam and two short beams, to each of which a tine is bolted. The overall weight of the cultivator is approx. 38kg. Bulawayo Steel Products also produce the BS2, which is a model with only two tines, similar to the BS3 but without the left-hand short beam and cultivating tine.

BULAWAYO STEEL PRODUCTS
8 Ironbridge Road, Donnington
P.O. Box 1603, Bulawayo
ZIMBABWE

HOLTAG WEEDER

The Holtag Weeder consists of three attachments. There are two adjustable blades, one on either side of the wheel, designed for weeding the sides of the ridges. In the centre at the back is a plough share, which cleans the furrow.

JOHN HOLT AGRICULTURAL ENGINEERS LTD.
New Industrial Estate
P.O. Box 352, Zaria
Kaduna State
NIGERIA



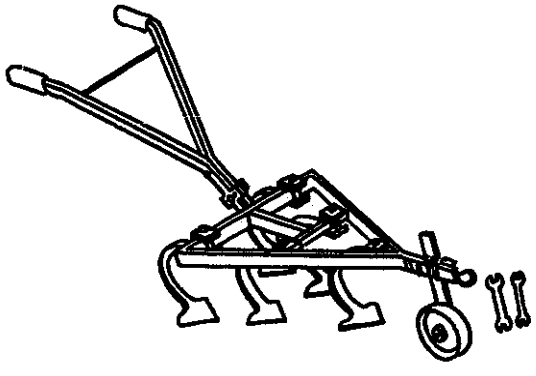
5-TINE CULTIVATORS

'5-TINE SCARIFIER' This cultivator is designed for tilling soil and for weed control (illustrated).

ELISHA ENGINEERING
38 Nabeka Street, P.O. Box 42, BA
FIJI

ANIMAL-DRAWN CULTIVATOR A similar 5-tine cultivator without land wheel.

RAM NARAYAN ENGINEERING
Koula Road
P.O. Box 271, BA
FIJI

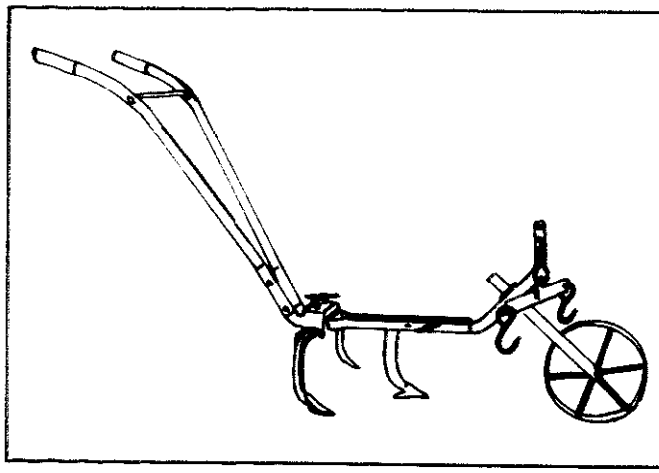


3- AND 5-TINE TRIANGULAR CULTIVATORS

C.N.E.A. and Uproma both produce a range of triangular cultivators. The basic frame can be fitted with 3- or 5-spring or rigid tines, or a plough-share, and the distance between the tines can be adjusted by sliding them along the frame to the required position. The working depth can be altered by the adjustment of the wheel, and the traction chain can be lengthened or shortened to maintain the cultivator at the correct angle.

C.N.E.A.
B.P. 7240, Ouagadougou
BURKINA FASO

UPROMA
B.P. 1066, Lomé
TOGO



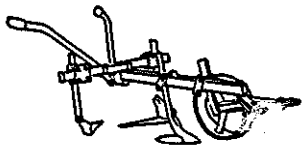
3 AND 5-TINE CULTIVATORS

WESTERN HOE 'OCCIDENTALE' This is a multi-purpose frame with 3 or 5 hoeing or duck-foot tines, weeding blades, a ridger, a plough fitting, or a seed drill. The distance between the tines can be adjusted by a screw mechanism above each tine. Weight: 18-25kg. (left).

SISMAR
B.P. 3214, 20 rue Dr. Theze
Dakar, SENEGAL

TYPE 100 CULTIVATOR This is a similar 3-tine cultivator with adjustable width ranging from 400 to 800mm. It is designed for ploughing vineyards and other cultivated areas ready for sowing and intercultivation. The working depth ranges from 100 to 150mm and is controlled by the amount of pressure applied.

FAPOK
Ulica M. Tita 25, 19353 Kaina
YUGOSLAVIA



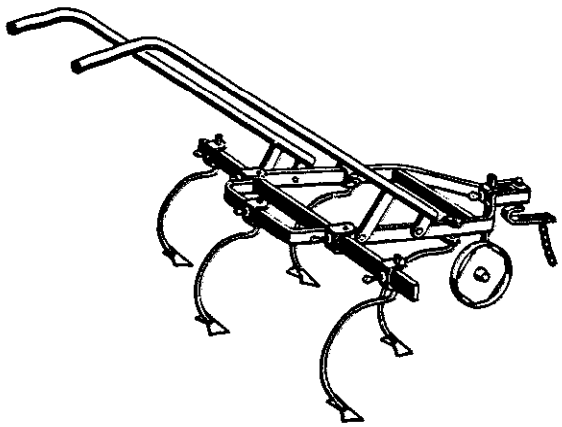
3-TINE CULTIVATORS WITH LAND WHEELS

ROW CROP HOE A 3-tine cultivator with adjustable width (illustrated).

ALVAN BLANCH DEVELOPMENT CO. LTD., Chelworth
Malmesbury, Wilts., SN16 9SG, U.K.

'HOUE SIPEX' A simple 3-tine cultivator which can be fitted with spring or rigid tines, ridging plough, groundnut lifter etc.

MARPEX
1 rue Thurot, 44000 Nantes
FRANCE



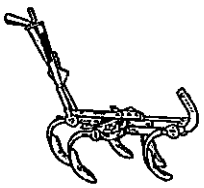
5-TINE CULTIVATORS

'HOUE SICAMIA' This (illustrated left) is a larger, heavier version of the Marpex 'Houe Sipex' featured above. It weighs about 50-100kg, depending on the attachments, and has a strong, square-shaped multi-purpose frame to which 5 tines can be fixed. As well as spring tines, as shown in the illustration, rigid tines, groundnut lifter and ridging plough are available as attachments.

MARPEX
1 rue Thurot, 44000 Nantes
FRANCE

NUBA GRECO HOE This is a cultivator with 5 spring tines and an adjustable width. The depth can also be adjusted by altering the wheel at the front.

E.B.R.A.
28 rue de Maine
B.P. 915, 49009 Angers Cedex
FRANCE



5-TINE ADJUSTABLE WIDTH CULTIVATORS

ANGULAR EXPANSION WEEDING HOE The illustration above shows this all-steel 5-tine cultivator which has a rachet lever for adjusting the working width. The working depth is 5-10cm. The tine fittings are all made from heat-treated carbon steel, and the overall weight of the hoe is 40kg.

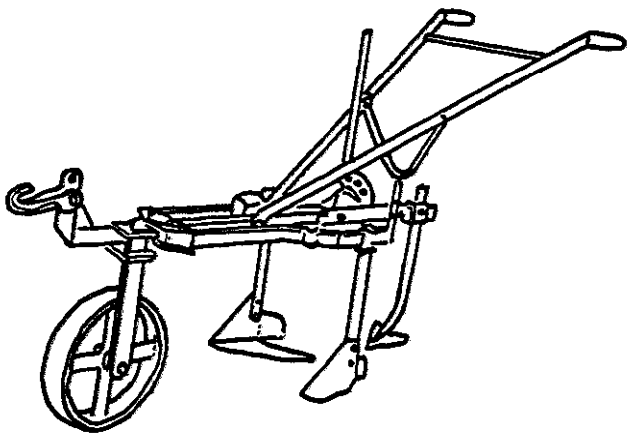
EICHER GOODEARTH LTD.
Deepak 3rd Floor
13 Nehru Pl, New Delhi 110019
INDIA

5-TINE CULTIVATOR Union Forgings produce a similar model to the Eicher cultivator above. It is designed for intercultivation of row crops and the overall width can be adjusted by means of a lever.

UNION FORGINGS
Sherpur, Ludhiana, Punjab
INDIA

AGRICOLA CULTIVATOR Agricola also produce a 5-tine adjustable width cultivator. The construction is however different from the models shown above. The 5 tines are fixed in a row to a cross-bar at right-angles to the beam. This is jointed where it connects with the beam. As the lever is operated, the ends of the crossbar are hooked to a 5-holed plate running alongside the front of the beam. As they are hooked further forward the crossbar ends swing forward, moving the outside tines to a narrower formation and making the width narrower.

AGRICOLA
34 rue Beni Amar, Casablanca
MOROCCO

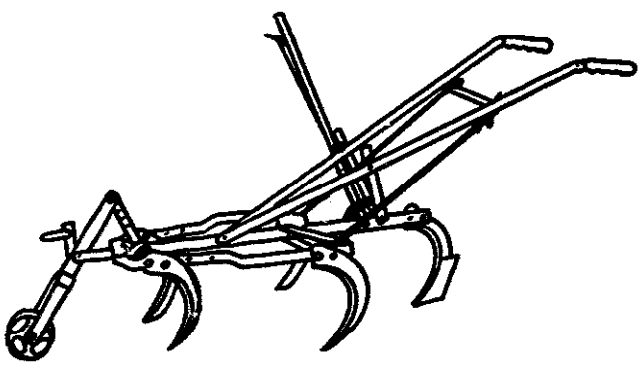


3-TINE LEVER-ADJUSTABLE CULTIVATORS

'PLANTATOR' P-409 HOE/LISTER (illustrated) Cultivates all root crops planted in ridges. Drawn by a horse its working width is adjustable from 22-63cm by lever, and various attachments are available. Capacity can reach 0.8ha/h. Manufactured by Wytwórnia Urz. Komunalnych, from:
AGROMET MOTOIMPORT
Foreign Trade Enterprise
P.O. Box 990, Warsaw, POLAND

TYPE 110 CULTIVATOR Like type 100.
FAPOK Ulica M. Tita 25
193[illegible] Kaina, YUGOSLAVIA

TYPE CO-0.6 CULTIVATOR. A light hoe for intercultivation and weeding. Available through:
CHINA NATIONAL AGRICULTURAL MACHINERY IMP. & EXP. CORP.
26 South Yeutan Street, Beijing, CHINA



5-TINE LEVER-ADJUSTABLE CULTIVATORS (WITH LAND WHEEL)

INKUNZI BS41 CULTIVATOR A 5-tine cultivator with lever for adjusting working width. Attachments available. (left.)

BULAWAYO STEEL PRODUCTS
8 Ironbridge Road, Donnington
P.O. Box 1603, Bulawayo
ZIMBABWE

BAIN MANUFACTURING COMPANY (PVT) LTD.
Box 1180, Harare
ZIMBABWE

ZIMPLOW CULTIVATORS Zimplow make two cultivators with a working depth of 75mm. S51 is a heavy model suitable for row crops between 610 and 1067mm. The 'Light Cultivator' is suited to narrow cultivation, e.g. between 475 and 75mm.

ZIMPLOW LTD
HIS Steelworks Road
Box 1059, Bulawayo
ZIMBABWE

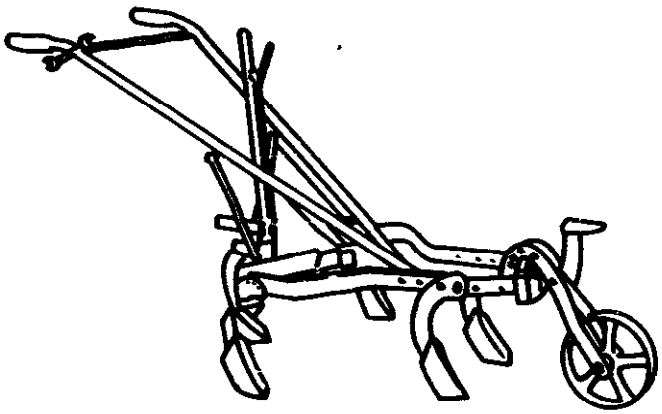
STANDARD CULTIVATOR A light yet sturdy cultivator with a working width of 60-115cm, adjustable by lever.

AGRIMAL (MALAWI) LTD.
P.O. Box 143, Blantyre
MALAWI

IDEAL CASEMENTS CULTIVATOR This model is very similar to the Inkunzi BS41 illustrated above.

IDEAL CASEMENTS (E.A.) LTD.
Box 45319, Nairobi
KENYA

CP5E 5-TOOTH CULTIVATOR Has a lever for adjusting width, and a regulator for altering depth, 2 cultivator teeth and a hiller blade set. Working width 90cm and working depth 5cm.
MARCHESAN IMPLEMENTOS E MAQUINAS AGRICOLAS TATU S.A.
C.P. 131, 15.990 Matão SP, BRAZIL



5-TINE LEVER-ADJUSTABLE CULTIVATORS

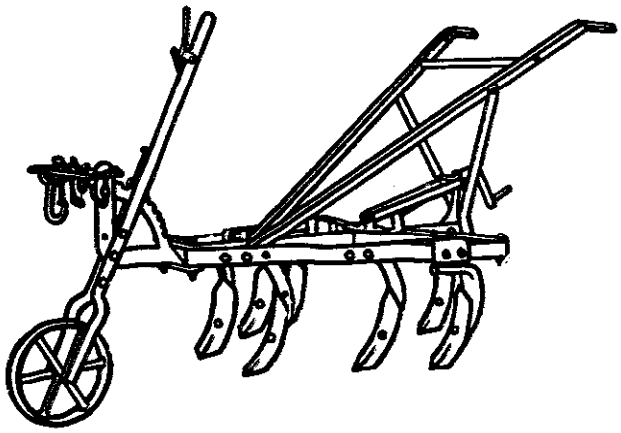
STEEL CULTIVATOR/HOE This (illustrated left) has an adjustable head-wheel which with the draught chain, regulates the depth. It can be used for working land already ploughed, as well as for inter-cultivating between rows of sugarcane, cotton, maize, potatoes etc. The width can be adjusted from 30cm to 45cm by a lever. Designed to be drawn by 2 bullocks; there are various attachments.
MAMUKI INDUSTRIES
P.O. Box 68, Ruiru
KENYA

CULTIVATOR No. MEC 8 Fitted with a lever for adjusting the tines, it has a working width of 350 to 600mm. Various attachments are available.
MODERN ENGINEERING COMPANY
1A, Anna Street, Velandi Palayam
Coimbatore 641 025, Tamil Nadu
INDIA

COSSUL & CO. PVT. LTD.
123/367-Industrial Area,
Fazalgunj, Kanpur, U.P., INDIA

BALDAN CULTIVATORS Baldan produce 3- and 5-tine cultivators with lever adjustable width, a depth wheel regulator and are for intercultivation of coffee, citrus, corn, soybeans, rice, groundnuts etc.
BALDAN IMPLEMENTOS AGRÍCOLAS S.A.
Av. Baldan 1500, C.P.11
15.990 Matão SP, BRAZIL

MARCHESAN CULTIVATORS
A range of 3- and 5-tine cultivators, made from steel with optional wooden handles. Working width can be adjusted by a screw or lever. Maximum working width 90cm and working depth 50cm.
MARCHESAN IMPLEMENTOS E MÁQUINAS AGRÍCOLAS TATU S.A.
C.P. 131, 15.990 Matão SP, BRAZIL



5-TINE SCREW-ADJUSTABLE CULTIVATORS

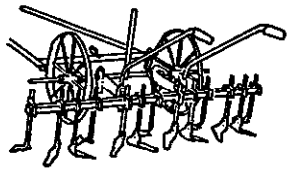
These cultivators are fitted with a screw mechanism which adjusts the working width. Various attachments are available, and the Marpex model can be fitted with 7 as well as 5 tines (Marpex model is illustrated).

MARPEX
1 rue Thurot, 44000 Nantes
FRANCE

TÉCHINÉ, ETS.
82400 Valence d'Agen (T & G)
FRANCE

AGRIMAL (MALAWI) LTD.
P.O. Box 143, Blantyre
MALAWI

ZIMPLOW LTD.
HIS Steelworks Road
Box 1059, Bulawayo
ZIMBABWE

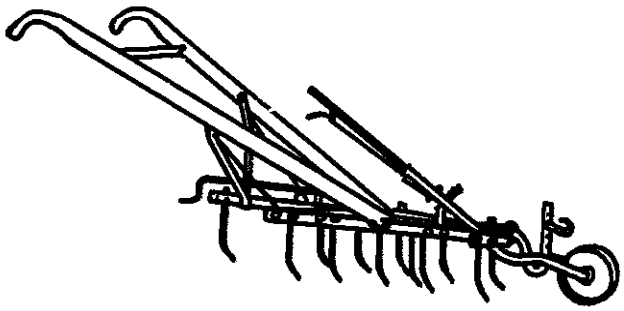


HORSE-DRAWN HOE P.433

Designed for intercrop soil cultivation and inter-row crop plantation, this hoe consists of a metal frame supported by two wheels, which can be adjusted horizontally. The working depth is 2-6cm, and the width between the blades can be adjusted from 30 to 90cm. Capacity is approx 0.5ha/h.

This horse-drawn hoe is manufactured by Agromet Zaklady Kuziennicze and is available through:

AGROMET MOTOIMPORT
Foreign Trade Enterprise
P.O. Box 990, Warsaw
POLAND



14-TOOTH CULTIVATORS

ROW PURIFIER No. 70 K.K. Lien manufacture the illustrated 14-tooth, row purifier constructed of steel with wooden handles. The teeth are of spring steel and are oil-tempered for longer wear. It is designed for uprooting weeds from between rows of vegetables. The teeth are adjusted by a screw mechanism to alter the working width. There is also a ratchet lever for adjusting the angle of the wheel and hence the working depth of the hoe. The row purifier No. 70 weighs 36kg and can be equipped with a 45cm furrower if desired.

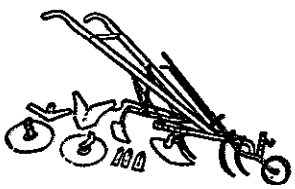
K.K. LIEN FABRIKK A/S
Tromøy, Arendal
4812 Kongshamn
NORWAY

CD14 ORCHARD HARROW This is a 14-tooth cultivator similar in design to the Row Purifier above. It is made of steel and may be furnished with wooden handles. Designed principally for destroying weed seeds, it has a lever for adjusting the width and an adjustable wheel to regulate depth. The harrow weighs 31kg, with a working width of 80cm and working depth of 5cm.

MARCHESAN IMPLEMENTOS E MÁQUINAS AGRÍCOLAS TATU S.A.
C.P. 131, 15.990 Matão SP
BRAZIL

BALDAN 14-TOOTH CULTIVATOR Similar to the above this cultivator has an adjustable depth wheel and a lever for altering the working width. Designed for breaking up hard subsurface soil layers for control against erosion it is also useful for seedbed preparation and intercultivation. It is drawn by one animal.

BALDAN IMPLEMENTOS AGRÍCOLAS S.A., Av. Baldan 1500, C.P.11
15,990 Matão SP, BRAZIL



5-TINE LEVER-ADJUSTABLE CULTIVATORS

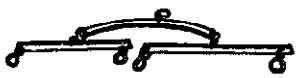
HORSE HOE No. 81 K.K. Lein produce the hoe shown in the illustration above. It is constructed of spring steel with wooden handles. The width of the side cutters is adjusted by a screw mechanism, and the depth wheel is also adjustable. Various attachments, including a mouldboard, rolling coulters and 17 to 37cm furrowers, are available.

The Horse Hoe can also be altered to a 10-tooth row purifier if desired.

K.K. LIEN FABRIKK A/S
Tromøy, Arendal
4812 Kongshamn
NORWAY

TECHINE CULTIVATORS Téchiné produce 3 models, the Multi-purpose Hoe, the African Hoe and the African Cultivator. The Multi-purpose Hoe has a screw adjustment for altering the width and a lever for regulating the depth. It has a working width of 40-70cm. The African Hoe is a simplified version of the Multi-purpose Hoe, with hand adjustment for depth and width regulation. The African Cultivator consists of the Multi-purpose Hoe from which the various attachments have been removed and replaced by steel spring tines.

TÉCHINÉ, ETS.
82400 Valence d'Agen (T & G)
FRANCE



HITCH EVENER

The normal arrangement for hitching two harnessed animals to implements is by means of a hitch evener comprising a straight or curved brace to which two 'swingle-trees' are attached. Traces from the swingle trees attach to the animals' harnesses.

The Bourguignon hitch evener illustrated above is specifically designed for the pulling of cultivation implements by two animals. It weighs 9kg.

BOURGUIGNON, S.C.A.D.
B.P. 17, 26301 Bourg-de-Péage-Cedex
FRANCE

HARNESSING EQUIPMENT MANUFACTURERS

BERLIN PAD SHOP
Rt. 6 Box 270
Millersburg, OH 44654
U.S.A.

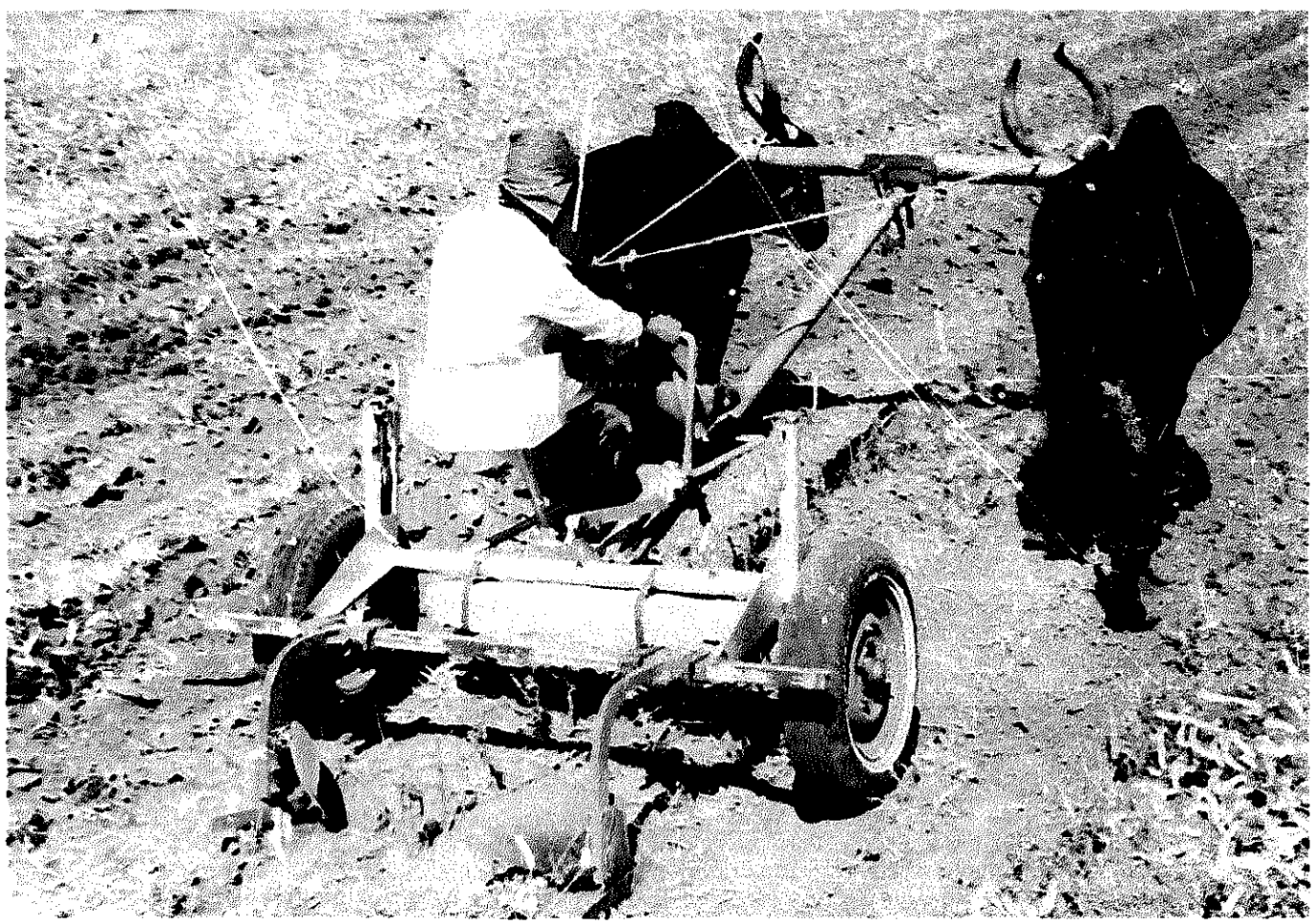
SCHROCK HARNESS SHOP
55 Poole Road
West Union, OH 45693
U.S.A.

LEGEARD
22-24 rue André Breton
61800 Tinchebray
FRANCE

PAUL I MURPHY
Box 307, 314 Park Street
Danvers IL 61732
U.S.A.

MAST HARNESS SHOP
Rt. 1, Box 228
Hazleton, Iowa 50641
U.S.A.

3. MULTI-PURPOSE TOOLBARS



NIAE

Multi-purpose toolbars have evolved relatively recently in response to changing circumstances in many developing countries.

With the very oldest of animal-drawn implements, the single tool was used as a multi-purpose implement — for primary land tillage, seed-bed preparation, seed covering and even inter-row weed control. Tools of this kind still exist in parts of the world (see Section 1) and are used in much the same way they were when they were first developed. They have the advantages of cheapness, versatility and ease of manoeuverability. They do suffer from some limitations in the efficiency with which they can carry out certain critical operations.

More recently, in Asia, appropriate implements have evolved to suit particular soil and climatic conditions, and although equipment for rice paddy preparation is often adequate, the range of animal-drawn tools for rain-fed, dryland agriculture is of limited versatility.

Attempts to modernize agricultural production systems in the developing countries have either focused on the transfer of western capital-intensive technologies or on the transformation of indigenous technologies through the introduction of adapted components from exotic systems. This has included new crops, varieties, fertilizer technology, crop protection techniques and crop processing technology. Until about 50 years ago there was little serious research and development work on improved tools, either hand- or animal-powered. It was assumed that either very simple adaptations to existing tools or the importation of European tools, would be adequate.

When it was finally realized that Western mechanization technologies would not transfer directly, some work began on improved tools. Much of this work focused on improved ploughs, but a number of engineers, working independently, developed the

Table 1. Working times for exclusively manual operations.

Operation	Groundnut			Maize	Millet		Cotton	
	Ivory Coast	Senegal	Chad	Ivory Coast	Senegal	Benin	Ivory Coast	Cameroon
	days/ha							
Tillage	40	15-20	10	40	—	13	8	15-20
Ridging	—	—	—	—	—	—	20	—
Fertilization	10	—	—	2	—	—	5	—
Sowing	5	10	9	6	4	7	8	5-10
Resowing	—	—	1	1	—	—	2	—
Weeding	30	15	20	24	12	31	60	30
Thinning	—	—	—	5	2	—	5	3-4
Harvesting	25	19	—	6	16	29	50	40-50

Note: Except where listed the source of tables is Binswanger, H.P., Ghodake, R.D., and Thiestein, G.E. (1979), 'Observations on the economics of tractors, bullocks and wheeled tool-carriers in the semi-arid tropics of India', in *Socio-economic Constraints to Development of Semi-Arid Tropical Agriculture*, ICRISAT, India, Feb. 1979.

concept of a multi-purpose toolcarrier, or toolbar. The principle of this idea is that the equipment consists of a main frame on which a range of soil-engaging implements can be attached to carry out the production tasks.

Multi-purpose toolbars can be divided into two main groups:

1. Simple, 'single row' equipment based on relatively modest modifications to the single furrow plough frame or light-weight 'T' or 'A' shaped frame (see pages 50, 51, 52 and 53). There are many variants of these and they have been developed for a wide range of conditions and environments. The main advantages of this group are cheapness and ease of handling and maintenance. They are usually suited to primary and secondary tillage operations and to simple, inter-row weeding work. There may be some limitations in the quality of work achieved, particularly in relation to planting and inter-row hoeing which may be critical operations in some environments. These implements may be drawn by single animals with neck or head yokes connected with chains and a simple spreader, or two animals with a single chain between them attached to a pole neck or head yoke.

2. A broader, two wheeled (or skids) implement that bears some resemblance to a tractor-mounted toolbar (see pages 54 and 55). This kind of implement is well suited to precision strip tillage or bed systems of soil, water and crop management and where time and sweep cultivation is feasible. Since the implement is often wheeled, it can also be converted to a cart, although most experience so far would indicate that the equipment is either used as a cultivator or a cart. Such equipment is drawn by two or more animals, though for light work, it would be possible for only one animal to be used.

Hitching systems vary depending on whether animals have a head or neck yoke, or whether collars are used. If a poke yoke is used (the most common arrangement) the dissel boom is usually attached to the centre of the yoke providing stability for the attached toolbar, and permits flexibility in adjusting working pitch of ground-engaging parts (see page 48). If collars are used on the animals, a more complex hitching arrangement is necessary, involving spacers behind each animal and a swingle tree attached to the horizontally held boom.

A number of engineers have also developed a range of intermediate types of implement, and manufacturers now offer a complete range of implements from very simple cultivators to very sophisticated wheeled toolbars which are capable of carrying out all the operations that can be done by tractor-mounted tools.

Some of the pioneering work was done on these types of implement over 50 years ago and recent work indicates that, in an appropriate crop system, these implements may have real advantages. Farmers are still reluctant, however, to adopt them on a wide scale: some of the reasons for this will be explored below.

The major tasks in crop production systems are: primary land tillage, secondary tillage (where necessary), fertilizer or manure application, seed-bed preparation, planting, post-emergence weed control, crop protection, harvesting, transport, processing and storage. In most small farm production systems all these operations are carried out by hand methods. However, where draught animals are available it is possible to improve the efficiency and timing of certain operations, reduce very onerous tasks and increase the area cultivated through the use of appropriate implements. The use of a multi-purpose toolbar enables farmers to carry out many of these operations and use their own labour more effectively.

Toolbars are considered to be particularly appropriate wherever tractors give a low rate of return (over most of the developing world), where hand methods do not result in adequate returns to provide basic family needs (probably over much of the semi-arid tropics), and where there is an inadequate range of single-function implements.

Advantages

It is necessary to stress that many of the benefits of this kind of equipment are only likely to occur when a number of complementary conditions are present. These include the presence of suitably fed and trained animals, competent handlers and machinery maintenance skills and the potential for additional returns from the use of this equipment above those received from present technology.

The possible benefits are:

- Versatility: the possibility of carrying out a range of tasks using the same basic tool with minor additions or adjustments.
- More effective soil and crop management technology, particularly in relation to seed-bed preparation and post-emergence weed control.

Table 2. Number of working days required to complete a working pattern (planting, weeding, thinning) in manual and animal-draught cultivation.

Crops	Pure manual cultivation (required days of manual work/ha)	Advanced animal-draught cultivation (additional days of manual work/ha)
Groundnut	25-35	10-14
Maize	36	10-14
Millet	18-38	18-24
Cotton	38-75	24-32

- Ease of operation. Once the equipment is adjusted, operations are generally easier than with conventional equipment.
- Lower cost. The total cost of the implement plus attachments is usually less than the cost of the equivalent range of single-operation implements.
- With the more elaborate toolbars, it is possible to cultivate a larger area of ground than with single-row equipment.
- Toolbar-based and other animal-powered technology is potentially labour enhancing rather than displacing as it can generate additional work in maintenance and also increase the opportunity for more frequent operations so that the quality of work is improved. (See Tables 1 & 2)
- Minimum tillage and other conservation techniques are possible using toolbars.
- Recent work in India indicates potential yield benefits on certain soil types. See Table 3.

Alternatives

The purchase of a multi-purpose toolbar may represent a considerable investment for many farmers and it may be beyond the capacity of poorer farmers acting independently. However, it could be possible for groups of farmers to purchase or hire such equipment, and this strategy may make sense where plots are very small and purchasing power is low.

Many farmers have access to very few alternative strategies in their current situation. The range of available equipment is low and of low quality, and the severely limited output potential of hand methods, particularly in drier rain-fed areas, results in a less than adequate output to meet basic needs.

Many field workers have attempted to develop local, low-cost versions of toolbars making maximum use of local skills and materials. While this may be feasible for small numbers of tools, it can rarely be sustained to provide the needs of the mass of the farm population. Quality control is also a major problem with production systems that start up with little experience. This does not rule out the possibility of local manufacture as, in fact, a number of the main manufacturers listed below developed in order to create such industries and, in most cases, they borrowed ideas from other sources.

Other alternatives are the hire of additional labour or the hire of tractors and appropriate equipment. For the bulk of the world's poor farmers these are not realistic alternatives, either because of a lack of sufficient resources at the appropriate time, or of an absolute lack of resources.

Choosing your equipment

Costs and benefits

There are many different toolbars to choose from (if they are available in a particular country). Major manufacturers produce a very wide range of equipment to suit many different situations. Inevitably choice is influenced by the cost of the implement and the expected return from its use in the production system.

The following represents approximate relative costs of toolbar equipment, and alternatives:

Table 4.

Equipment	Capital	Running
Single row or basic toolframe	100	10
Full range of attachments	100	10
Double or multiple row toolbar	500	40
Range of attachments	300	30
Single operation implements (per item)	80-100	10

This return may be influenced by a number of factors outside the control of the farmer, such as soil type, fertility, climate, topography etc, but it may also be influenced by the quality of operations — land

Table 3. Yield increases attributable to cultivation practices with wheeled tool carrier at ICRISAT Centre.[a]

	Steps in Improved Technology (SIIT) experiments, with improved soil management[b]				Watersheds	
Variety:	Local	Local	Improved	Improved	Improved	Improved
Fertilizer:	Local	Improved	Local	Improved	Improved	Improved
					Maize followed by chickpea	Maize and chickpea intercropped
Alfisols	234	802	262	1285		
Medium-deep Vertisols					−190	−206
Deep Vertisols	546	533	479	1046	+166	+625

Source: Ryan, Sarin, and Pereira (1979, Appendix Tables 1 and 2 and Table 3). A fuller description of the experiment is given there. See also Annual Report Farming Systems Program, 1976-7.

a. Averages are for 1976-7 and 1977-8 and are expressed in rupees per hectare of net cropped area. The experiments reported here were carried out with seeding attachments that were more expensive than the ones used for the calculations in Table 4. However, the engineers expect to achieve the same precision with the cheaper devices budgeted.

b. During the year 1976-7 the improved management treatment also included a minor level of insect control, but the differences in 1977-8 are fully attributable to soil management techniques.

Table 5. A comparison of annual bullock labour inputs for some operations by traditional methods and with the wheeled tool carrier.

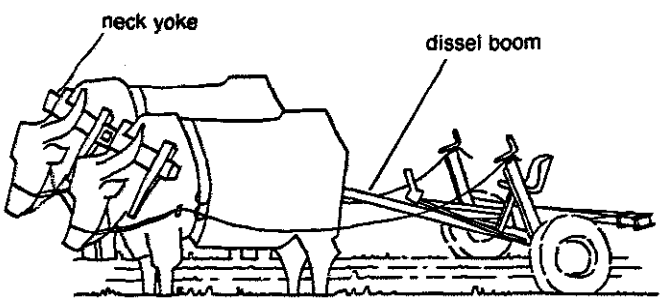
Soil type (village)	Operation	Existing village practice (average of 1975-6 and 1976-7) (pair hr/NCA)	Traditional method as defined on ICRISAT research watersheds 1977-8 (pair hr/NCA)[a]	Broadbed-and-furrow system with wheeled tool carrier 1977-8 (pair hr/NCA)
Medium-deep vertisols (Kanzara)	Preparatory tillage	45.7	70.3	25.8[b] 18.0[c]
	Manuring & fertilization	2.4	—	7.1[b] 5.1[c]
	Sowing, transplanting etc.	12.5	6.3	7.4[b] 4.5[c]
	Interculture	24.8	—	6.1[b] 5.2[c]
Deep vertisols (Kalman)	Preparatory tillage	25.6	30.5	24.3[b] 18.4[c]
	Manuring & fertilization	1.5	—	6.6[b] 3.3[c]
	Sowing, transplanting, etc.	10.3	12.2	6.6[b] 3.2[c]
	Interculture	7.6	—	7.6[b] 7.3[c]

a. NCA — Net cultivated area. b. Sole maize followed by chickpea. c. Maize intercropped with pigeonpea.

preparation, timing of planting, timing and accuracy of weeding etc. Though farmer management ability will influence this quality, it is also affected by the quality and versatility of the toolbar. In general, the simple toolbars will show little benefit in quality of operation over conventional equipment, whereas the larger toolbars (provided that complementary technologies are introduced) can show considerable improvements in quality of operation.

Unfortunately there has been very little reliable work carried out on the economic evaluation of multi-purpose toolbars, but work in West Africa, India and Botswana has given some indication of the potential of this equipment. The Indian work indicates that the benefits are only fully realized when the equipment is incorporated into a well-planned soil- and crop-management system.

The main economic benefits would appear to accrue from better timing of operations, better weed control and better soil and water management. Labour productivity is generally increased and there is scope for greater employment.



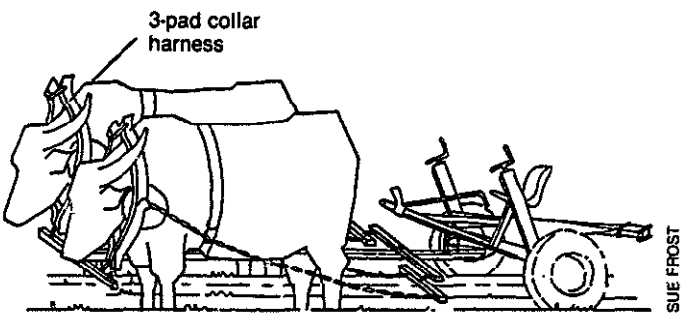
Pair of animals with neck yoke and dissel boom attached between them and to multi-purpose wheeled tool carrier.

Social impact

There is little evidence so far on the social impact of multi-purpose toolbars, as the numbers produced are still relatively low, apart from West Africa, (see Tables 6 and 7) and it is too early to assess these effects.

Some of the potential benefits are likely to be similar to those produced by the introduction of any new cultivation equipment — namely, the removal of drudgery and the opportunity for more members of the household to assist in the crop production processes. It is thought unlikely that the technology would be labour displacing, though this is possible where plots are small and such implements are controlled by a few wealthy farmers. Only through the ownership and control of the means of production will small-holder farmers benefit from these toolbars.

The larger toolbars allow the introduction of major changes in land and crop management techniques, such as land forming and double or multiple row planting and weed control. The simpler range of toolbars can also be used in ridge systems (for instance) but their speed of



SUE FROST

Pair of animals with three-pad collars hitched to multi-purpose tool carrier with horizontally held boom, spacers and swingle tree.

Table 6. Equipment numbers in West Africa

Items	Upper Volta	Mali	Mauritania	Niger	Senegal	Chad	Benin
Bullock-drawn ploughs	12,050						
Donkey-drawn ploughs	4,470						
Total ploughs	16,520	106,700	2,400[1]	3,000	8,000	58,056	7,450
Tool carriers (multiculteurs)	2,500	40,555		4,300 }	204,000	1,727	185
Cultivators (donkey, horse-drawn)	21,000	14,058		900 }			
Harrow		10,739					
Seeders		9,707	100[1]	900	220,000		
Carts		52,204		3,300	89,600	14,606	
Ridgers (ridgers and/or weeders)				1,500	5,000	(3,883)	
Lifters				3,300	88,000		

1. Tentative figures.

Table 7. Average density of animal-drawn equipment in West Africa (ha/unit).

Items	Upper Volta	Mali	Niger	Senegal	Chad
Plough	190	12	900	278	19
Multiculteur or hoe	160	31	690	11	199
Ridger	—	—	—	445	199
Harrow	—	116	—	—	—
Seeder	8,800	129	3,020	10	—
Lifter	—	—	820	25	—
Cart	325	24	820	25	76

operation is inevitably slower.

Other considerations are: the presence of adequate repair and servicing skills and facilities, either on farm or in local villages; the presence of skills in animal draught training and management; and the role of livestock in the current farming system.

The significant technical characteristics that need to be borne in mind are the need to obtain an implement and fittings that are appropriate to the present and future needs of the farming system. The operation and maintenance of this equipment generally requires a higher degree of skill than with most older equipment. A minimum range of repair and adjustment tools are necessary, as is the commitment of a certain amount of time to ensure efficient operation.

It is also usually essential to develop concurrent improvements to animal linkage and harnessing systems to ensure efficient operation. Maximum benefit can be obtained with healthy, fit, well-trained animals and with equipment in good condition.

The type of animals that are available is also an important factor. Small oxen or donkeys, often found in the drier and poorer areas, will only be able to pull the smaller types of toolbar. Camels, larger oxen, mules or horses will be more appropriate for the larger equipment.

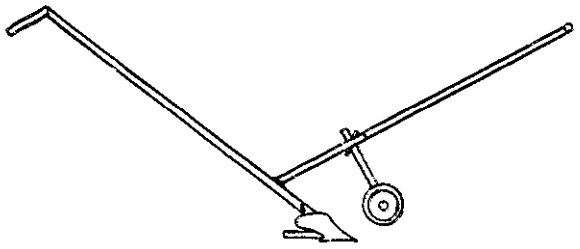
Special considerations

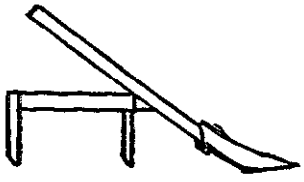
Maintenance is obviously important, as badly adjusted equipment will not perform any better than alternative single-operation equipment. A range of spares or repair facilities are essential for uninterrupted operation in the growing season.

The equipment alone will not lead to significant benefits without the development of an understanding of its potential value in a cropping and farming system. Appropriate animals, training and harnessing, and rational soil and crop management techniques will all contribute to the improved stability and productivity of the cropping system.

In most areas of the developing world the benefits of the multi-purpose toolbar, above those produced by older conventional equipment, have yet to be proven. In many situations they may not be appropriate, but in others they may be highly relevant and beneficial. Support from governments and external agencies may be necessary to explore the potential for this new equipment fully.

David Gibbon
University of East Anglia

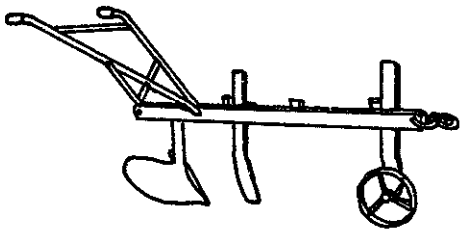


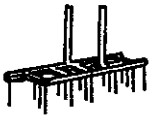


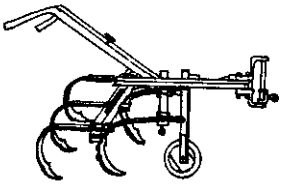
TWO-PERSON TOOLBAR

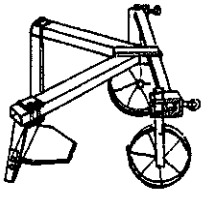
The two-person toolbar is a light-weight, multi-purpose implement suitable for use on small areas of land. By applying the strength of two people, one pulling, and the other pushing and steering, a reasonable performance can be attained. Attachments available at the present time include: plough, ridger, hoe and six-tine harrow. All fittings are secured by a single pin and the depth wheel can be adjusted without the use of tools. To aid ease of transportation and storage the front beam is detachable.

PROJECT EQUIPMENT LTD.
Industrial Estate, Rednal Airfield
West Felton, Oswestry
Salop SY11 4HS
U.K.









ANIMAL-DRAWN TOOLBARS

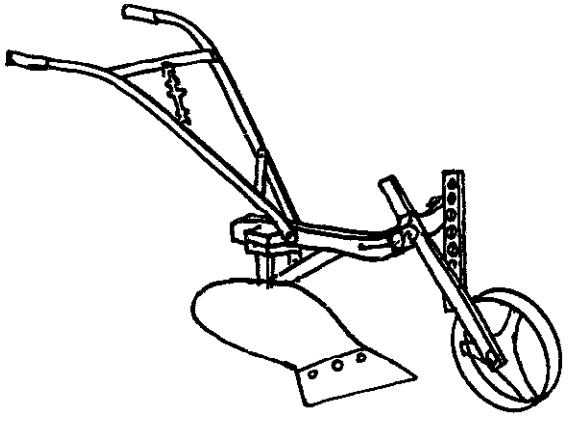
The attachments to these toolbars are mounted on the angle-bar frame by ring-type pinch bolts, avoiding the need for spanners.

The toolbar produced by Agri-projects International Ltd. (top panel) is equipped with 175 mm plough body plus coulter blade and depth wheel, ridger body and 17-tine drag harrow. Agri-projects require a minimum order of 40 units.

The toolbar manufactured by J.P. Parmiter & Sons Ltd. is similar but has a T-frame telescope handle and also includes attachments (at left) for a 3- or 5-tine cultivator and a root crop lifter.

AGRI-PROJECTS INTERNATIONAL
P.O. Box 191, Maison Alfaire
Smith Street, St. Peter Port
Guernsey, C.I.
U.K.

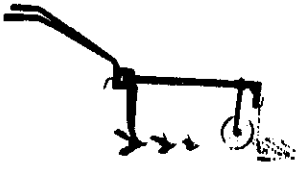
P.J. PARMITER & SONS LTD.
Station Works, Tisbury
Salisbury, Wiltshire SP3 6QZ
U.K.

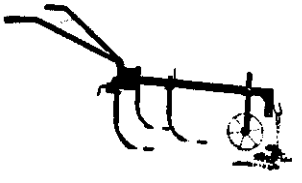


MULE-DRAWN TOOLBAR

The equipment, designed by SMECMA for animal draught, is light-weight (12.5 kg) and may be used for ploughing, hoeing/weeding and groundnut lifting. The steel frame and depth wheel give the plough working widths and depths of 10-15 cm and 15-17 cm respectively.

SMECMA
B.P. 1707, Bamako
MALI





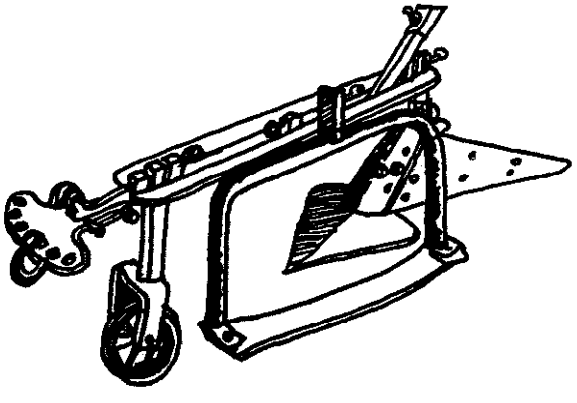
E.B.R.A. OMNICULTOR

E.B.R.A. have produced this simple animal-drawn toolbar to which a wide range of implements may be attached. Shown here are the rigid and spring-tined harrows (top) and the 25 cm mouldboard plough, ridger body and furrower (below). In addition to these the following attachments are available:

1. Digger with 3 different blade widths.
2. Earthing up and ploughing attachment.
3. Two-row planter.

The toolbar frame is constructed of steel, and features adjustable handles and depth wheel.

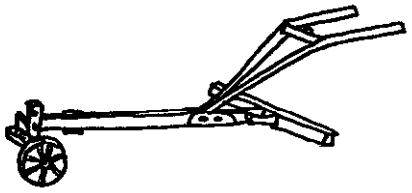
E.B.R.A., 28 Rue du Maine
B.P. 915, 49009 Angers Cedex
FRANCE



MULTI-PURPOSE TOOL FRAME

An animal-drawn, multi-purpose toolbar comprising a basic frame to which a series of attachments, including plough, ridger, groundnut lifter and cultivator, can be fitted. Further fittings such as soil pulverizers and planters are currently being developed.

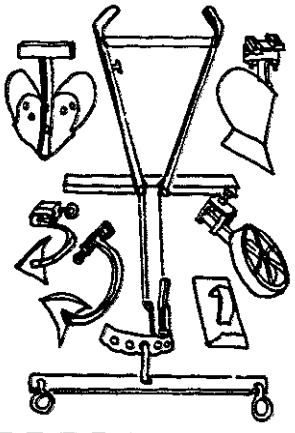
AGRI MAL (MALAWI) LTD.
P.O. Box 143, Blantyre
MALAWI



MULTI-PURPOSE TOOL FRAME — THE 'HOUE C'IWARA 731'

In addition to the ploughing attachments shown here, SMECMA also manufacture a digging plough, 3-tine cultivator and ridger, all of which may be used with this basic frame.

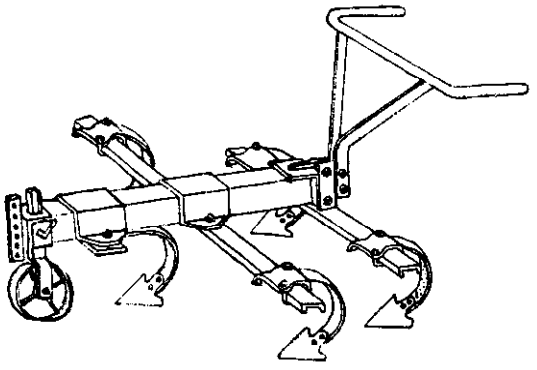
SMECMA
B.P. 1707, Bamako
MALI

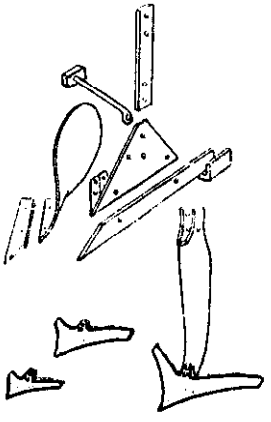


MULTI-PURPOSE, HORSE-DRAWN CULTIVATOR (MPHDC)

The toolbar and attachments developed at the Ministry of Agriculture have recently been introduced into Tongan farming. Production is very limited and so far only five MPHDCs have been incorporated into the demonstration unit of the Extension Division. Project workers are hopeful that the design, based on the tried and tested French 'Houe-Sine' model, will be widely adopted. The MPHDC is a simple, all-steel, construction, equipped with plough, ridger and cultivator. Also featured is an adjustable depth wheel and twin coupling for animal draught. The simplicity of design will allow manufacture and maintenance to be carried out locally.

DEPARTMENT OF AGRICULTURE
P.O. Box 14, Nuku'alofa, TONGA





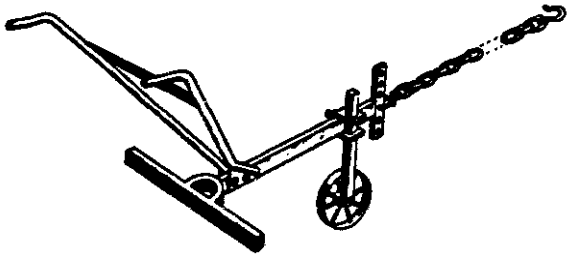
THE 'ARARA' MULTI-PURPOSE FRAME

The 'ARARA' multi-purpose cultivator can be used for different tillage and crop cultivation operations, as well as groundnut lifting. The different attachments are fitted onto the main frame which is equipped with adjustable handles and depth wheel.

The cultivator, including all available attachments, has a total weight of 71.8 kg. This is made up of the following: main frame (19.5 kg); a 25 cm plough-body with draught regulator (16.8 kg); a 3- or 5-tine Canadian cultivator (20.9 kg), ridging plough with adjustable wings and reversible tip (8.8 kg); and a groundnut lifter with 200, 350 and 500 mm blades (5.8 kg).

The above equipment can be ordered in combinations as required.

ARARA
30 Rue d'Anjoy, 78000 Versailles
FRANCE



'SINE 9' MULTI-PURPOSE FRAMES

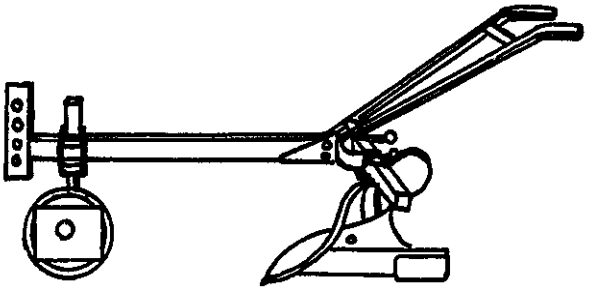
Seven adaptable units are available: 1 x 8 or 10 HUARD UCF plough-frame, 1 ridging plough with mobile blades, 1 groundnut lifter (3 blades), 1 x 3-tine Canadian hoe or 5-tine with adaptor, 1 excavator pick (3- or 5-teeth), 2 double seed drills, settings from 30 to 90 cm.

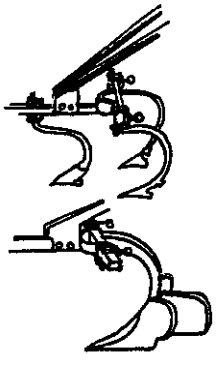
Additional features are: vertical setting (for trailing), horizontal setting (for width), equipment coupled with clamps and eye bolts, interchangeable wheel with iron bushing, adjustment and draught chains, weight 30 to 45 kg according to equipment.

Also available is the 'Sine Greco' which uses the same attachments as the 'Sine 9', but has a heavier frame.

SISMAR
B.P. 3214, 20 Rue Dr. Theze, Dakar
SENEGAL

STE NOUVELLE MOUZON
B.P. 28, 60250 Mouy (Oise)
FRANCE





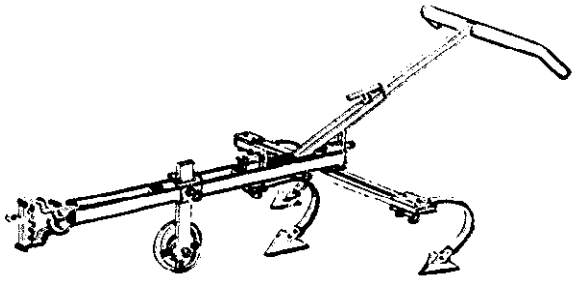
BASIC IMPLEMENT FOR MULTIPLE TILLAGE

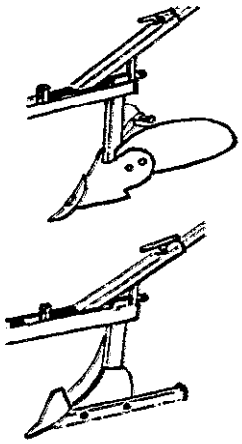
The Rau multi-purpose toolbar can be used with a number of attachments for cultivation operations. With reference to the drawings, the components consist of:

1. Basic frame.
2. Gauge wheel.
3. Steel plough body with exchangeable wear parts.
4. Cultivation tines for soil loosening and weed control in row crops.
5. Adjustable ridger for ridge cultivation or furrow-irrigated crops.

There is also a two-row precision seeder (See Section 4).

RAU MASCHINENFABRIK GmbH
Johannes-Rau-Straße
7315-Weilheim an der Teck
W. GERMANY





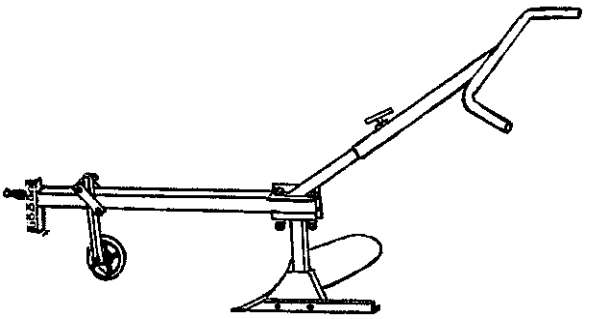
THE ADAPTABAR

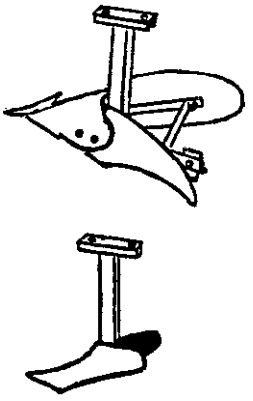
A heavy-duty, multi-purpose toolbar strong enough to be used with a 2 or 4 oxen team or pulled by a small tractor. Additional attachments to the 3- or 5-tine cultivator, 22 cm plough and planet ridger pictured here include: roller seeder, groundnut/potato lifter, two-row planter, subsoiler, 5-tine sweep and roller clod breaker. These may be combined where appropriate.

Attachments are retained by ring bolts passing through the stalk, but the thrust is taken by the central frame inserts which are welded in place. Twin A-shaped tube handles can also be supplied.

A heavier frame for hard soil conditions is also available.

PROJECT EQUIPMENT LTD.
Industrial Estate, Rednal Airfield
West Felton, Oswestry
Salop SY11 4HS
U.K.





THE PECOTOOL

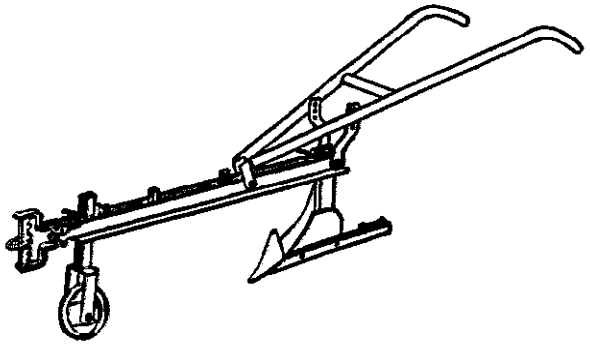
This is a multi-purpose, animal-drawn toolbar designed specifically for Sierra Leone conditions. The Pecotool was initially produced by Project Equipment, but recently the all-steel implement has been manufactured locally in Sierra Leone itself as part of a Work Oxen Project.

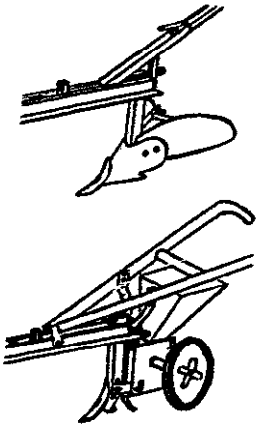
The toolbar can be used with either a 22 cm or 15 cm plough and is supplied with both a wheel and skid. The handle is adjustable, as is the hitch.

Other attachments available are a planet ridger, 5-tine cultivator, groundnut lifter and single row seeder.

PROJECT EQUIPMENT LTD.
Industrial Estate, Rednal Airfield
West Felton, Oswestry
Salop SY11 4HS
U.K.

SIERRA LEONE WORK OXEN PROJECT
P.M.B. 766, Freetown
SIERRA LEONE





THE ANGLEBAR

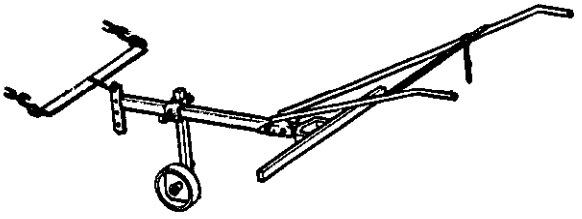
Considerably lighter than the Adaptabar, the Anglebar is a multi-purpose model which is within the pulling capacity of smaller draught animals such as ponies, mules, or small oxen.

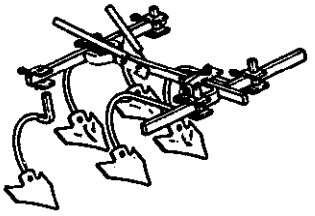
Available attachments shown are the 22 cm plough, planet ridger and roller seeder.

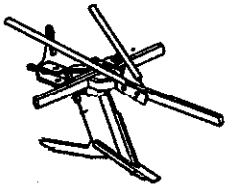
The Anglebar is manufactured from steel sections which are widely available in many countries, and is intended for production in small workshops possessing only basic equipment.

The main frame is made from angle iron, with handles of water pipe (either A- or T-shaped). The handles are adjustable for height, and the attachments are secured by ring bolts passing through the stalk and mounting points on the frame.

PROJECT EQUIPMENT LTD.
Industrial Estate, Rednal Airfield
West Felton, Oswestry
Salop SY11 4HS
U.K.





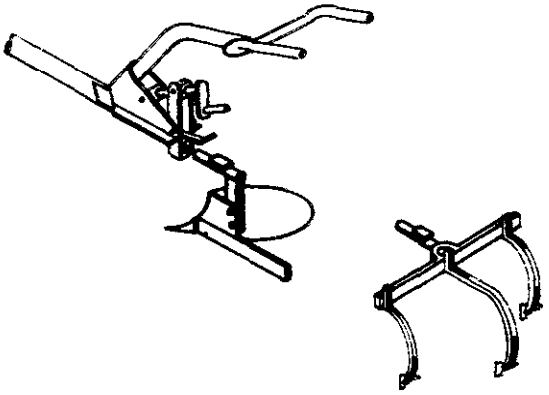


CEMAG POLICULTOR 300

A well-equipped yet simple multi-purpose toolbar, the Policultor 300 can handle up to 7 attachments. Additional to those shown here are a furrower, 5-tine cultivator, drag harrow and seeder.

The Policultor 300 is designed to be drawn by one or two animals and has a basic weight (without attachments) of 24 kg. It is suitable for the cultivation of areas up to 3 hectares.

CEMAG
Rua João Batista de Oliveira 233
06750 — Taboão da Serra
São Paulo
BRAZIL



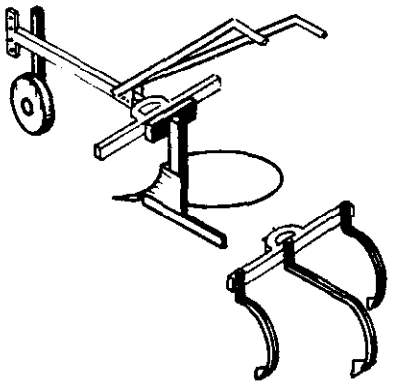
THE KANOL TOOL SHAFT

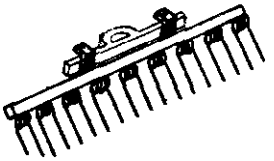
The Kanol Tool Shaft is available in two forms, one to be drawn by a single animal, the other by two animals. The shafts feature a quick coupling device to which a wide range of attachments may be fitted. These include:

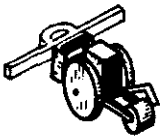
1. Plough
2. 3-tine cultivator
3. Subsoiler
4. Harrow
5. Scraper
6. Furrower
7. Clod crusher
8. Lifter
9. Leveller
10. Seeder

BELIN INTERNATIONAL
2 Mail des Charmilles, B.P. 194
10006 Troyes Cedex
FRANCE

STE NOUVELLE MOUZON
B.P. 28, 60250 Mouy (Oise)
FRANCE



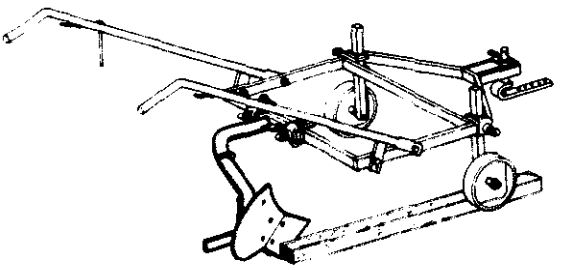


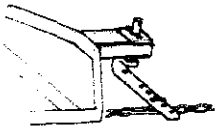


THE SIMONE MULTI-PURPOSE TOOLBAR

The Simone is a simple animal-drawn toolbar with a total of 12 possible attachments. In addition to those shown here, the following are available: tiller/fertilizer-spreader, harrow, clod crusher, seeder, stabilized (2-wheel) plough, and scarifier.

BELIN INTERNATIONAL
2 Mail des Charmilles, B.P. 194
10006 Troyes Cedex
FRANCE





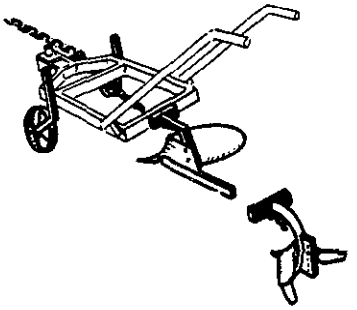
CEMAG POLICULTOR 600

A more advanced model than the Policultor 300, this multi-purpose toolbar is larger and requires greater draught power, and can be fitted with a wider range of attachments. These include

1. Mouldboard plough
2. Furrower
3. Sub-soiler
4. Tiller — with teeth
5. Cultivator
6. Teeth harrow
7. Planter
8. Planter/fertilizer
9. Reversible mouldboard plough
10. Ridger
11. Rake

The Policultor 600 is a 2-wheeled system with a weight (minus attachments) of 48 kg. It is suitable for the cultivation of up to 6 hectare small-holdings.

CEMAG
Rua João Batista de Oliveira 233
06750 — Taboão da Serra
São Paulo
BRAZIL



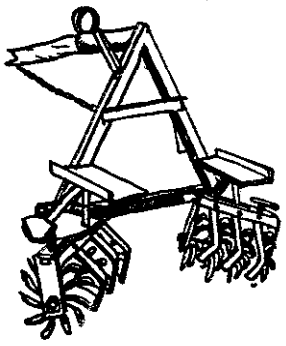
THE MARIANNE MULTI-PURPOSE TOOL BAR

MARIANNE is the third in Belin's range of multi-purpose cultivators, and offers more sophisticated characteristics than the Simone and Kanol. Drawn by 1 or 2 animals, instead of a single-bar frame, the 'Marianne' features a rectangular frame onto which 1 to 3 wheels and one of a choice of 12 implements may be attached. Being larger than the other models it is able to handle double-row attachments and cultivators with a higher capacity than those with 3 tines only.

Available attachments are:

1. Single plough
2. Reverse plough
3. Cultivator (7-tine)
4. Furrower
5. Ridger
6. Peanut lifter
7. Double plough
8. Cultivator (5-tine)
9. Canadian harrow
10. Potato lifter
11. Subsoiler
12. Seeder

BELIN INTERNATIONAL
2 Mail des Charmilles, B.P. 194
10006 Troyes Cedex
FRANCE

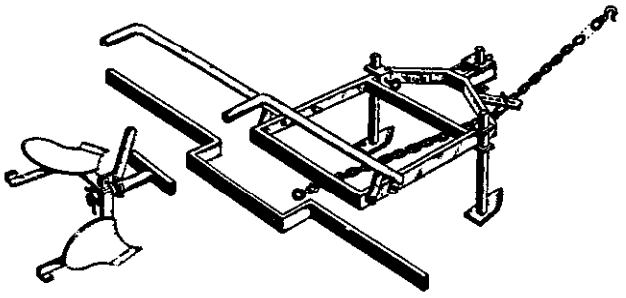


THE HOLTAG STRAD

The STRAD animal-drawn, multi-purpose toolbar is designed for ridging, planting, fertilizer application and weeding of crops grown on ridges.

The system consists of the following:
1. Frame.
2. Cross bar.
3. Reversible point and mounting.
4. 2 × 4-gang rotary cultivators.
5. Seed and fertilizer box.
6. Seat and attachment.

JOHN HOLT AGRICULTURAL ENGINEERS LTD.
New Industrial Estate
P.O. Box 352, Zaria
Kaduna State
NIGERIA



ARIANA MULTI-PURPOSE FRAME

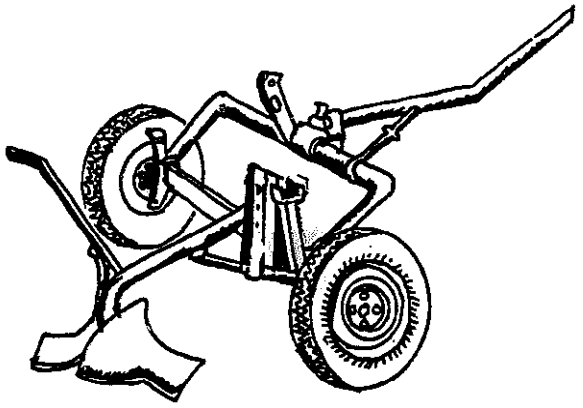
A heavy-duty toolbar, the Ariana is suitable dor difficult soil conditions and rice fields. It features 1 or 2 × 25 cm HUARD UCF cut-away ploughing frames, 1 × 25 cm HUARD UCF quarter turn plough, 1 ridging plough with movable wings, 1 × 3 blade groundnut lifter, 1 × 6- or 8-tine Canadian harrow, 1 × 1.5 m extension bar.

Additional characteristics include:

Third wheel at rear of frame, adjustable handles, assembly with clamps and eye bolts, interchangeable wheels with iron bushing. Weight 58-92 kg according to equipment mounted.

The Mouzon Tropiculture also has a disc ridger, a 20-tine harrow, leveller, seeder/fertilizer, sub-soiler etc.

SISMAR
B.P. 3214, 20 Rue Dr. Theze, Dakar
SENEGAL
STE NOUVELLE MOUZON
B.P. 26, 60250 Mouy (Oise), FRANCE



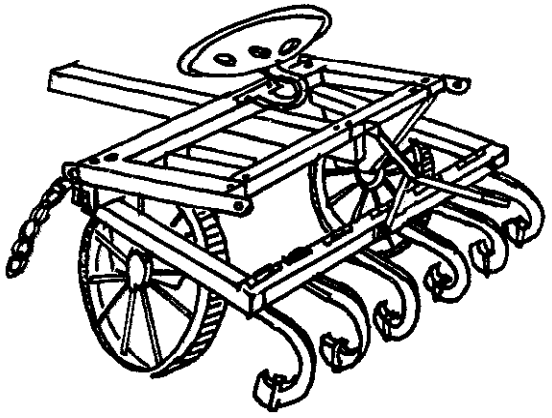
THE BAOL POLYCULTIVATOR

Special features of the animal-drawn Baol Polycultivator include pneumatic wheels, variable guage and swivelling beam. Adaptable units are: 1 × 25 cm HUARD UCF plough frame, 2 ridging ploughs with mobile wings, 2 groundnut lifters (3 blades), 1 × 2 m articulated toolbar, 8 or 12 weeding-hoeing teeth (shown here), 1 × 2 m tip-up cart tray, 1 × 3-row seed drill, Super Eco type.

Additional characteristics: Articulated retractable ploughshare (optional), adjustable handles, large adjustable row-tracer, disconnection and lifting of seed drills, combined ploughshares, space between rows available from 30 to 120cm.

The Baol Polycultivator can also be adapted for use with a small tractor.

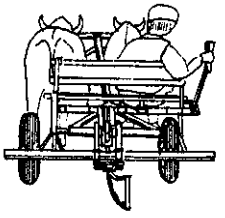
SISMAR
B.P. 3214, 20 Rue Dr. Theze, Dakar
SENEGAL
STE NOUVELLE MOUZON
B.P. 26, 60250 Mouy (Oise), FRANCE



LIONESS ANIMAL DRAWN IMPLEMENTS

The all-steel, fully welded Sahall range of animal-drawn implements can be adapted for ploughing, disc harrowing, cultivating, 2-row ridging or furrowing, 2-row precision seeding, weeding between crop rows, or as an animal-drawn cart with a capacity of up to 500 kg. Pictured left is the main frame fitted with drawbar, operator's seat and toolbar with 6-cultivator tines. A feature of this model is the standardization to metric size M.12 of all bolts and nuts in the mainframe, toolbar and attachments. Only one size of spanner is required to carry out adjustments. In addition, three different types of wheel are available to match the local soil and crop conditions. The wheels are fully adjustable throughout the 3 metre length of the main frame and toolbar.

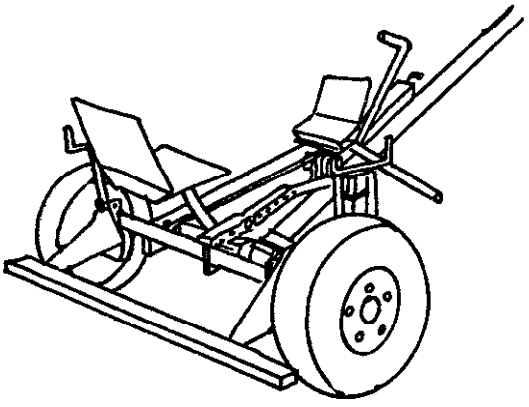
SAHALL LTD.
Soil and Water Resources
13 Leachfield Industrial Est.
Garstang, Preston PR3 1PR, U.K.



CAPSTA II MULTICULTIVATOR

Developed from the CAPSTA I, this wheeled multi-purpose cultivator may be adapted for use in many field operations, including transportation.

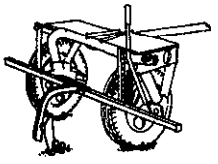
OFICINA VENCEDORA
Av. Sete de Setembro, 599
56.300 Petrolina, PE
BRAZIL



KRUSHI UDYOG MULTI-PURPOSE WHEELED TOOL CARRIER

Suitable for ploughing, cultivation, ridging, inter-cultivation and transportation, the Krushi Udyog Multi-purpose Wheeled Tool Carrier is recommended by the Indian Crop Research Institute for dryland cultivation in deep black vertisole soils. It is drawn by 2 bullocks and comprises the main frame mounted by the operator's seat, two wheels with pneumatic tyres, a mild steel rectangular section toolbar, a spring-loaded adjustment mechanism to control the depth of operation. The multi-purpose tool carrier is most suited to broad bed and furrow cultivation systems.

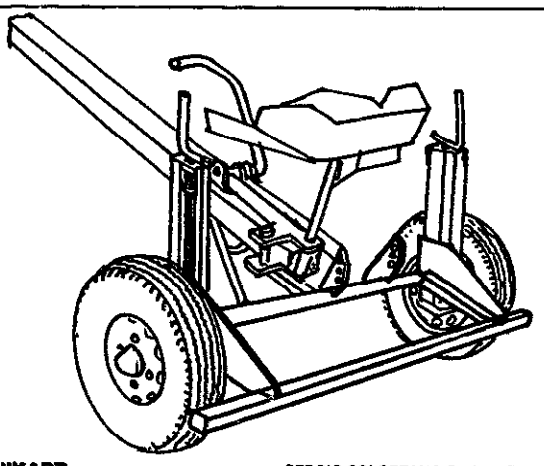
THE MAHARASHTRA AGRO IND. DEV. CORPN. LTD.
Rajan House, 3rd Floor
Nr. Century Bazaar, Prabhadevi,
Bombay 400 025, INDIA



UNIVERSAL MULTI-PURPOSE TOOL CARRIER

Vicon have designed this animal-drawn tool carrier for a wide range of attachments for land cultivation. These include mould board plough, cultivator, disc harrow, ridger, sub-soiler, and seed and fertilizer applicator.

VICON LTD.
K.R. Puram-Whitefield Road
Mahadevapura Post
Bangalore 560 048, Karnataka
INDIA



THE NIKART

The Nikart is a wheeled tool carrier consisting of a frame mounted on 2 wheels (usually with pneumatic tyres) with a beam or draw-pole to which a bullock yoke is fastened. The basic frame has a toolbar onto which a variety of implements can be attached with simple clamps. Working depth can be adjusted to meet operational requirements, and a lifting mechanism is provided to raise or lower the implement into position.

The Nikart can be supplied with a range of attachments which enable it to be used for:

1. Tillage:
- Reversible or non-reversible disc or mouldboard plough.
- Ridger.
- Disc, spike or spring-tooth harrow, and cultivator.
- Ridgers and float for bed farming.

2. Planting and fertilizer application:
- Fertilizer application either separately from or in combination with planting.
- Most cereal seeds, peas, beans and cotton can be planted in variable row arrangements and at required spacing. Intercropping can also be carried out.

3. Transport

The Nikart may be obtained from the following manufacturers:

GEEST OVERSEAS MECHANISATION LTD.
Marsh Lane, Boston
Lincolnshire PE21 7RP
U.K.

MEKINS AGRO PRODUCTS (PVT) LTD
6/3/866/A
Begumbed
Greenlands
Hyderabad 500016
INDIA

SRI LAKSHMI ENTERPRISES
65-1 1st Main Road
Ramchandra Purim
Bangalore 560 021
INDIA

VOLTAS LIMITED*
Strand House
19 Graham Road
Ballard Estate
Bombay 400 001
INDIA

SERGIO SOLORZANO DE LA VEGA**
Balboa 125 Esquina Jacarandas
Fraccionamiento Virginia
Veracruz, Ver.
MEXICO

LA VICTORIA S.A.
Ozumba
MEXICO

KALE KRISHI UDYOG
S16/A Narayan Path,
Pune 411 030
INDIA

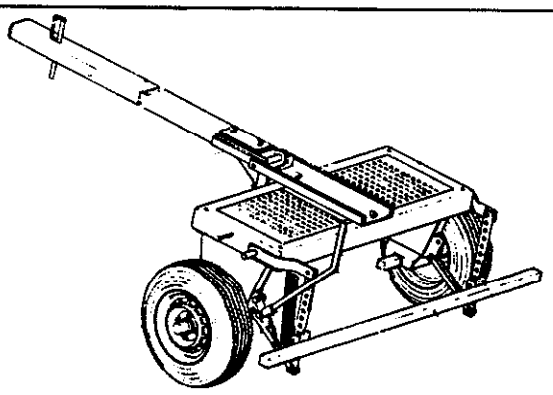
GURUNATH INDUSTRIES
65/1 1st Main Road
Ramachandrapuram
Bangalore 560 021
INDIA

CEARA MAQUINAS AGRICOLAS S/A
Av. Gaudioso de Carvalho, 217
Bairro Jardim Iracema
Caixa Postal, D-79
60.000 - Fortaleza - CE
BRAZIL

MEDAK AGRICULTURAL CENTRE (EQUIPMENT)
Cathedral Compound
Medak
Andhra Pradesh 502 110
INDIA

PONTAL MATERIAL RODANTE S/A
Rua Campante No.237
Vila Independencia
Caixa Postal, 833
01.000 - São Paulo - SP
BRAZIL

*Trade name is 'KRISHI RATH'.
**Trade name is 'YUNTICULTOR'.



THE AGRIKART

The Agrikart comprises a steel frame mounted on motorcar wheels. A wide range of implements can be attached to the frame, including: mouldboard plough, ridger, cultivator, weeder, disc harrow, seeder, scraper blade, trailer.

These implements are attached to the frame with clamps. Changing implements and adjusting working depth, pitch and wheel track, are possible without the use of spanners. The Agrikart is designed to be drawn by two bullocks and is suitable for use on areas of up to 15 hectares. The Agrikart and similar designs are manufactured by the following companies:

AGRIKART
MEDAK AGRICULTURAL CENTRE (EQUIPMENT)
Medak Agricultural Centre (Equipment)
Cathedral Compound, Medak
Andhra Pradesh 502 110
INDIA

TROPICULTOR
MEKINS AGRO PRODUCTS (PVT) LTD
6/3/866/A
Begumbed
Greenlands
Hyderabad 500016
INDIA

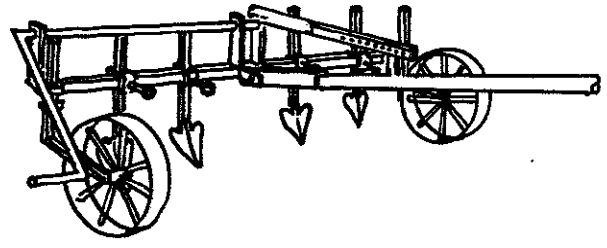
TROPICULTOR
Ste Nouvelle Mouzon
B.P. 26, 60250 Mouy (Oise)
FRANCE

POLICULTOR PONTAL
Pontal Material Rodante S.A.
Rua Campante No. 237
Vila Independencia
Caixa Postal, 833
01.000-São Paulo, SP
BRAZIL

POLICULTOR 1500

This model is equipped with a wider range of attachments which, in addition to those given above, include: furrower, subsoiler, rake, single beam, liquid fertilizer tank, fertilizer spreader, water tank.

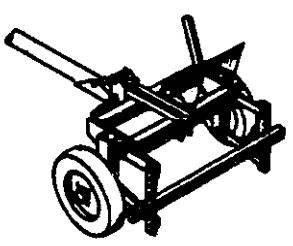
CEMAG
Rua Joao Batista de Oliveira 233
06750 — Taboao da Serra, São Paulo
BRAZIL

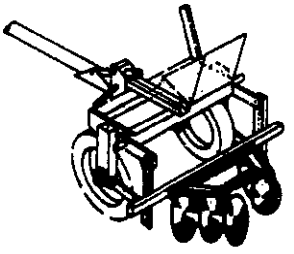


THE AGRIBAR

The Agribar is essentially similar to the Agrikart in that it is equipped with the same 40 x 40 mm square tool bar, and is able to carry the same range of attachments. The Agribar is, however, considerably lighter, and is not provided with pneumatic tyres. These facts allow the Agribar to be cheaper than other toolbars of an equivalent function.

MEDAK AGRICULTURAL CENTRE (EQUIPMENT)
Cathedral Compound, Medak
Andhra Pradesh 502 110
INDIA





POLYNOL ANIMAL-DRAWN AGRICULTURAL TOOL BAR

The Polynol is the most sophisticated of the Belin range of animal-drawn toolbars. For the three chassis types produced for this model, the following attachments are available:
- plough (1 or 2 bodies)
- reversible plough
- cultivator
- harrow
- disc harrow
- sub-soiler
- ridger
- lifter
- ridge leveller
- leveller
- cereal seeder
- fertilizer spreader
- precision seeder
- sprayer
- ridge seeder
- furrow seeder
- grass cutter
- rotary reaper
- charrette
- tip cart
- water tank
- unloading cart
- semi-trailer
- weeder
- hoe
- mixer
- roller
- ridge with disc
- cane-sugar planter
- potato planter

BELIN INTERNATIONAL
2 Mail des Charmilles
B.P. 194, 10006 Troyes Cedex
FRANCE

STE NOUVELLE MOUZON
B.P. 26, 60250 Mouy (Oise)
FRANCE

4. SOWING, PLANTING AND FERTILIZER DISTRIBUTION

PAUL STARKEY

In order to achieve good yields when growing vegetables, cereals, legumes and root crops, the depth of seeding and the spacing between the plants should be uniform and optimal for the given growing conditions. However, to facilitate weeding and other operations the plants are often confined to rows, usually with a distance between them that is less than that between the rows. To achieve the best compromise, various designs of hand-operated and animal-drawn seeders and planters have been developed which control, to a greater or lesser extent, the plant density by means of the spacing in each row of seeds and other planting material. Most seeders and planters can also be used to distribute fertilizer. Combined seeder/fertilizer drills are used to drill fertilizer into the soil at optimal distance from the seeds at the same time as sowing.

Seeders and fertilizers

Seeds and planting material are placed in the ground in three ways:

- Seeds can be broadcast on the soil and are then usually buried by raking, harrowing or scattering earth over them.
- Seeds, tubers or other vegetative material, and seedlings can be placed in holes in the ground which are then refilled with soil.
- Seeds and other planting material can be placed in a furrow, opened to the appropriate depth, then closed again and lightly compressed.

Broadcasting

Broacasting can be done by hand scattering or by using a hand-operated broadcaster which is usually slung over

the shoulder of the operator (Fig.1). These broadcasters are often called seed fiddles, a name acquired because

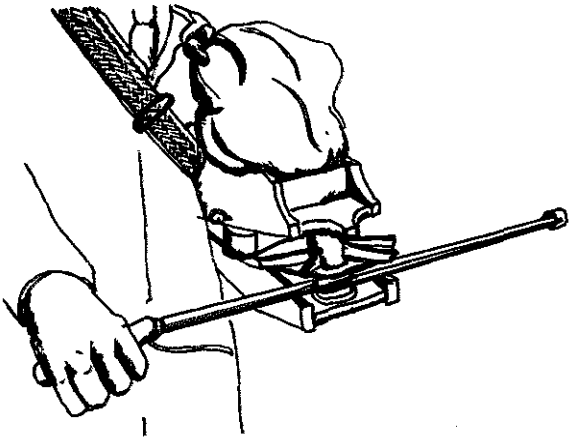


Fig.1 Seed fiddle.

of the bow stick handle used to drive the spinner. The leather thong of the bow passes around a bobbin which is attached to the ribbed spinner. By moving the bow from left to right the spinner rotates, scattering the seed which falls onto it from the canvas seed bag. The rate of seeding can be altered by loosening a wing-nut under the fiddle and moving the slide to the setting required, thus altering the aperture of the hole through which the seed trickles. Broadcasting requires considerable skill on the part of the operator to achieve an even distribution.

Alternatively a uniform coverage can be achieved by a spinning-disc distributor driven by its wheels through a gear box. These are usually two-wheeled and can be pulled or pushed by one person, with larger versions being animal-drawn. Broadcasters can also be used to distribute granular pesticides (see Section 5).

Dibbling

Dibbling seeds and other planting material in holes in the soil is the oldest form of planting. Distances between plants can be precisely determined by the operator. Often more than one seed or plant is placed in each hole. A variety of pointed sticks, some with metal tips, are commonly used for this purpose (Fig.2). Manually operated 'walking stick' and rotary injection 'jab' planters

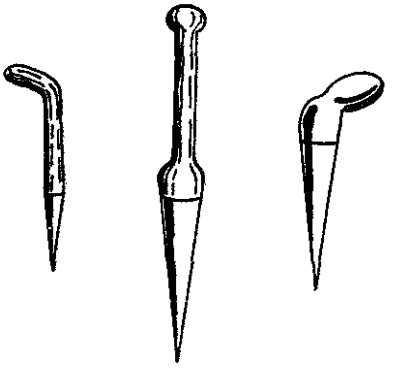


Fig.2 Dibblers: (left to right) steel tipped (Léon Clément); steel tipped (Kumaon); all steel (Wolf).

are used for both seeds and fertilizers. Jab planters can be used in quite rough seed-beds or uncultivated land, so long as the ground is soft enough. They are useful for filling gaps in rows and can also be used to place fertilizers.

The principle of 'jab-planting', as applied to the rotary injection machine, incorporates 6 jabbing devices around its circumference. Hand-pushed versions of this design have been developed and introduced in Nigeria with some success.

Seed is picked up from the hopper by the feed roller which contains pockets of a suitable size for the crop concerned. The seeds then fall into the jabbing devices which remain closed until just before withdrawal from the soil, at which point they open and the seeds drop into the hole. The distance between each jab depends on the diameter of the rotary wheel, the length of the jabbing devices and the depth to which the jabbing devices penetrate the soil; for maize the distance between holes is about 250 mm. This is achieved by a wheel of about 350 mm in diameter with the jabbing devices protruding by about 75 mm.

A variation of the dibbler is used to plant large vegetative material (e.g. potatoes), seedlings, or cuttings. The soil engaging point of the planter can be opened wide enough to allow the material to be placed manually at the correct depth.

Row seeding

Row seeding or planting can, at its simplest, be achieved with a plough or other furrow-making tool and the seeds or other material are dropped in the furrow at the appropriate intervals. The furrow can then be closed. Hand-pushed row seeders (usually single row) normally require a well-prepared seed-bed. In unmetered seeders the seed usually trickles into the furrow from a mounted container. Alternatively, in animal-drawn one- and two-row seeders an operator is sometimes required to feed the material manually, either by means of a sowing tube or directly into the furrow.

The design of seed coulter and sowing tube affects the width of line within which the seeds are sown. Figure 3

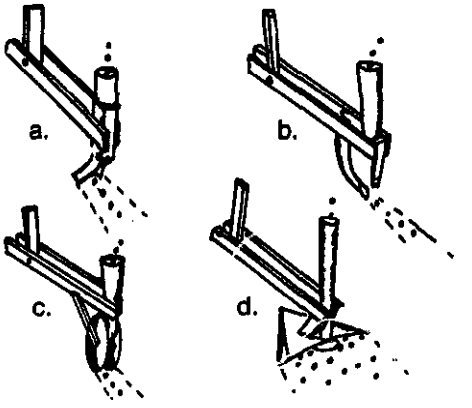


Fig.3 Seed Coulters: a. cultivator type share, b. drag share, c. double disc share, d. goose-foot share (for strips).

shows four types of coulter, the narrowest of which, the drag share, is only of use in well-prepared seed-beds. The cultivator and double disc coulters can break up a slightly hardened soil surface to create a narrow furrow into which the seeds fall. The goose-foot share creates a wide furrow, and a small plate fixed to the bottom of the sowing tube causes the seed to scatter across the width of the furrow, producing a wide band of plants. It is common to trail a metal chain, ring or other small harrow behind the seeder to make the coverage of the seed more complete.

Seed drills

The more sophisticated seed drills usually have seed-metering mechanisms in order to achieve a predetermined spacing of plants in the row. The metering devices are driven by ground wheels which ensure that the rate of seeding is directly related to the distance travelled.

The simplest form of drill is the direct drive seeder in which the metering mechanism takes the seed from the hopper using a seed roller mounted on the same axle as the ground wheel. This is usually used for single row vegetable seeders (Fig.4).

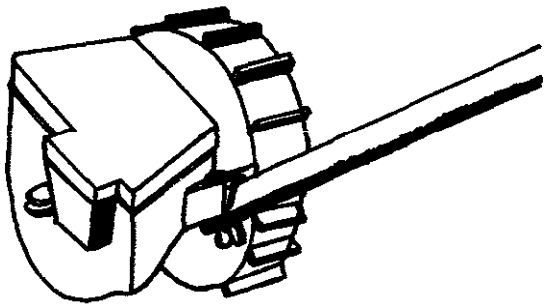


Fig.4 Rolling seed drill — single-row vegetable seeder.

More sophisticated precision seeders have metering mechanisms driven from the axle of a ground-wheel. One type uses a Pitman drive which connects a drive crank mounted on the axle to a drive crank on the seeder (and also to a second crank on the fertilizer distributor, in the case of seeder/fertilizers — Fig. 5). An improvement on this design is the use of double Pitman drives, both of

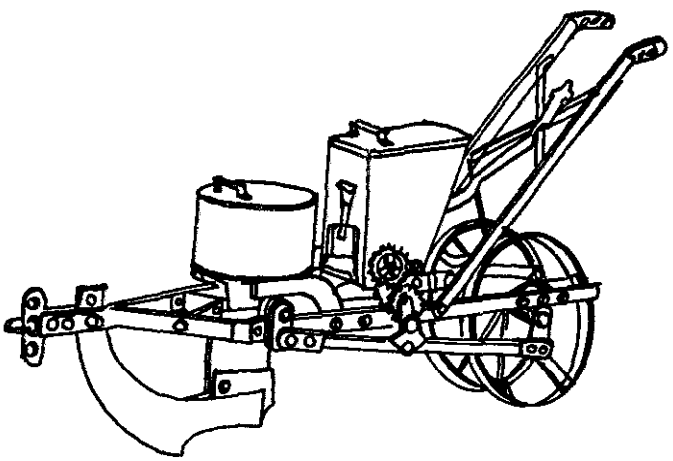


Fig.5 Single-row seed and fertilizer drill with Pitman drive.

which connect the seeder and fertilizer mechanisms to cranks mounted on each end of the ground wheel axle.

A second, more common, type of drive uses a chain driven by a sprocket mounted on the ground wheel axle. The chain passes around sprockets connected to the seeder mechanism (and fertilizer distributor, if mounted — Fig.6).

Precision seeders, usually chain driven, are often available for mounting on multi-purpose toolbars (see Section 3).

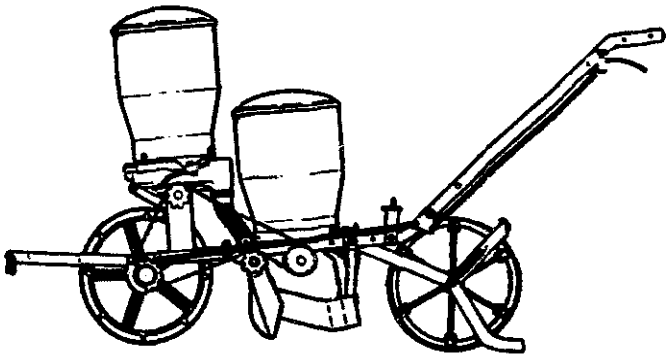


Fig.6 Chain and sprocket driven planter/fertilizer.

Seed-metering mechanisms

Various mechanical seed-metering systems are used. A rotating brush or agitator controlling the flow of seed through an adjustable opening will handle most types of seeds with minimal damage, as will contra-rotating soft rollers, but these mechanisms do not closely control seed spacing in the row. Fluted roller-feed mechanisms (Fig.7) give more accurate control of overall seed rate per hectare, but again do not control spacing in the row. Cell-

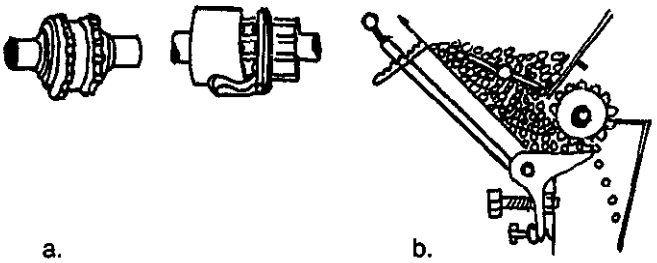


Fig.7 a. Fluted roller and slide roller-feed mechanisms, b. Seed roller.

wheel and perforated belt-metering systems can give very precise spacing of seeds — particularly those which are approximately spherical in shape. The metal cell wheel (Fig.8) is more likely to cause damage to delicate seeds than the flexible perforated belt. Some seeders

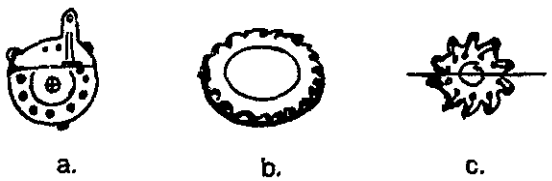


Fig.8 Seed metering wheels and plates: a. vertical cell-wheel, b. horizontal feed disc, c. spoon disc.

can be adjusted to plant groups of seeds at long intervals. Most can be adjusted for various seed sizes and spacing so as to achieve an optimal plant population with a minimal use of seed.

Fertilizer distributors

The distribution of manure and fertilizer is often done entirely by hand. Organic manures and compost are usually spread over a whole field or between plant rows and incorporated by subsequent cultivation. Similarly, inorganic fertilizers can be broadcast by hand scattering or by using mechanical broadcasters. They can also be placed on the surface between plant rows and then be incorporated, or be dibbled in beside plants or seed placements. Granular or pelleted fertilizer can be drilled into the soil at an appropriate distance from the plants using seeders. This method of distribution is often done at the same time as seeding or planting, frequently using dual-purpose equipment.

Advantages

The benefits of using precision equipment are higher crop yields. These should be achieved because:

- Correct seeding depths lead to better germination and uniform crop stands.
- Precision seeding results in an optimum plant population and reduces seed consumption.
- Good quality seeders improve the speed and accurate timing of the sowing.
- Use of row seeders/planters allows easier weeding and other operations; it also makes possible contour planting which may help to reduce erosion.
- Fertilizer drilled into the soil provides plants with readily available nutrients; the timing of application can be related to the plants' needs.

Alternatives

The more labour-intensive methods referred to above have been used since agriculture began. They are still the commonest methods used by poor smallholders. Although precision equipment is not used, the quality of planting need not be any less optimal, given sufficient care and the time of skilled operators. And in certain circumstances — e.g. when sowing stony uncultivated land, or when using odd corners of fields or in gardens — these labour-intensive methods are the only viable ones.

Choosing your equipment

Before buying equipment some thought should be given to:

- The possibilities of adapting existing equipment e.g. by adding a planting tube to a plough.
- The availability and cost of planting material (such as specialist seed) and pelleted fertilizer.

Points to consider when selecting equipment include the size of area to be sown in a single holding and the possibilities for hiring out the equipment to neighbours; the power source available and the typical condition of seed-beds; the possibilities for multi-purpose use with a wide range of seed shapes and sizes; and the level of sophistication required.

Having decided on the particular type of equipment required the buyer needs to look at each model with regard to:

- robustness, expecially that of the seed metering mechanism;
- ease of maintenance and availability of spares;
- ease with which seed metering and seed size alterations can be made; and
- skill level of the operator(s).

The cost spectrum of this type of equipment is very wide and the only point worth emphasizing is that the price increases significantly for precision over and against gravity-flow seeders. Also the repair and maintenance costs of precision seeders and the extra cost of the prepared seed and fertilizer may in the long run exceed the capital cost of the equipment.

Before investing in expensive precision seeders it is necessary to calculate the opportunity costs. To assist in this calculation the following table shows average performance data.

Type of equipment	*Draught required (kg)*	*Average performance per day (8 hours)*	*Notes*
Single row planter/seeder (hand-operated)	15-30	0.3-0.6 ha	Depending on soil conditions as well as row width.
Single row planter (animal-drawn)	25-40	0.5-1.0 ha	Length of field, and thus number of headland turnings, affects performance.
Double row seeder (animal-drawn)	35-65	0.8-1.5 ha	
Seed drill (1.25 m)	55-65	1.0-1.5 ha	
Seed and fertilizer drill (hand-operated)	20-30	0.3-0.6 ha	
Fertilizer distributor (animal-drawn)	35-70	1.0-2.5 ha	Depending on type of equip. & width of swath.

Impact

The introduction of mechanical seeders may displace labour. However, in particular circumstances this can be avoided, if, for example:

- the equipment introduced, such as a plough planter, still requires a similar number of people to operate it, although the work load may be less arduous;
- the area to be sown increases significantly and the labour is redeployed operating and supplying several seeders;
- the use of the equipment allows sowing to be carried out where previously it has proved difficult, e.g. the sowing of red peas between the rows in post-harvest sugar-cane fields.

Special considerations

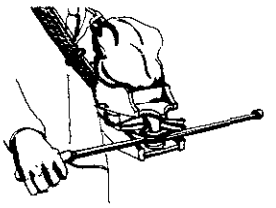
The health and safety of operators who may be handling material treated with fungicides and insecticides is of paramount importance. Special training should be given in the handling of such poisons and, where appropriate, protective clothing should be provided (see Section 5).

Peter Munzinger
GTZ/GATE

RICMAR SEED FIDDLE

Seed fiddles broadcast seeds and fertilizers. This model has 3 settings with the following performances:
1. 5.5 kg clover seed or 33 kg ryegrass seed per ha and 4.88 m at a cast; 2. 186 kg barley seed per ha and 7.32 m at a cast; 3. 278 kg oat seed per ha and 4.88 m at a cast.

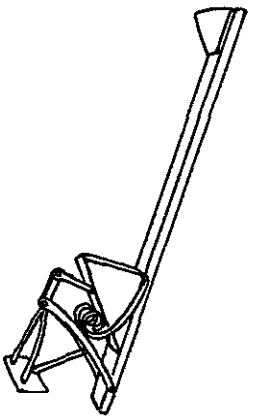
M.E. TUDOR
Frogmore Cottage, Sawyers Mill, Minety
Nr. Malmesbury SN16 9QL, Wilts, U.K.



SEED FIDDLE

This shoulder-slung fiddle is suitable for broadcasting seeds, grain and granular fertilizers over small acreages or patches affected by flood or drought.
This model features 3 rate settings.

ALVAN BLANCH DEVELOPMENT CO. LTD.
Chelworth
Malmesbury SN16 9SG, Wilts.
U.K.



HAND SEEDERS

Better Farming Equipment supply 2 models, one with a hopper and one without. For the latter the seed is hand-fed down a tube in the handle when the point is open in the soil. This is a valuable method for filling in gaps in rows. (Illustration above.)

B.F. EQUIPMENT
30080 Sde Yaakov
ISRAEL

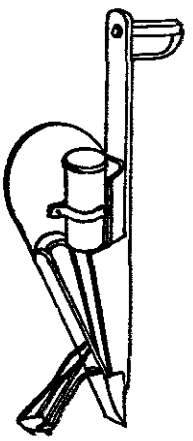
JAB PLANTER

Originally designed at the Asian Institute of Technology, Bangkok, this hand-operated planter can plant areas of soya bean and small seeds at a depth of 4 cm. The single action of jabbing the planter into the ground actuates the seeding mechanism and the seeds are deposited into the hole in the soil on the upward spring-assisted return stroke. The simple aluminium seeding drum can be cut out as required to give 2 different sized slots for the number of seeds per unit area, for 2 types of seed. A retracting foot pedal is featured for use in harder soil conditions.

CHAIPRADIT KARNCHANG
235 MOO 8
Chiang Mai-Hang Dong Road
A-Hang Dong, Chiang Mai
THAILAND

Also available is a very similar but slightly more sophisticated jab planter (not illustrated).

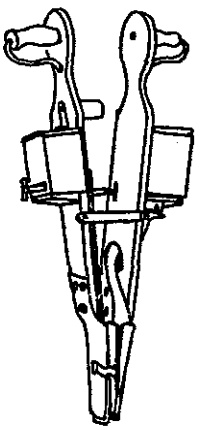
LAMBERT CORP.
519 Hunter Avenue
P.O. Box 66, Dayton, OH 45404
U.S.A.



HAND MAIZE PLANTER

This simple spring-action jab planter places single seeds at the required depth. The planter is placed in the ground at a certain depth and pushed forward onto the spring-loaded foot. This action causes the point to open and deposit a seed in the soil. At the same time the seeder is recharged from the hopper. A spring action mechanism returns the planter to the vertical and the operator then removes the planter from the soil (usually) walking backwards to plant the next seed. Interchangeable discs with variable hole sizes can be used for planting single seeds for a range of crops from millet to beans. It is particularly useful for planting cotton, maize and groundnuts.

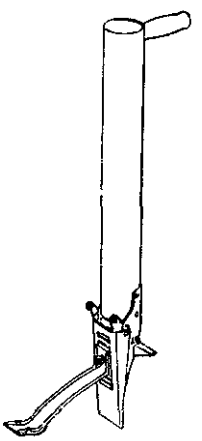
COSSUL & CO. PVT. LTD.
123/367 — Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA



COMBINED FERTILIZER AND SEED PLANTER

This instrument is suitable for a variety of seed crops. The double-action mechanism can be adjusted to allow the required flow of seed and fertilizer. Several other models are available. (Illustration left.)

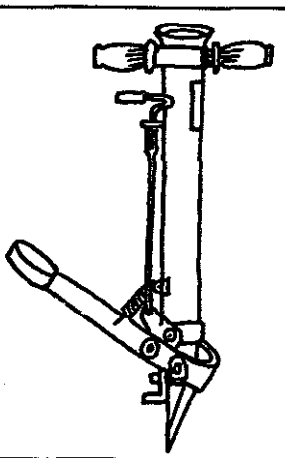
KRUPP
Schier, Krupp and Cia Ltda
Rua Bento Gonçalves 3030
93,300 Novo Hamburgo, RS
BRAZIL



SPADE POTATO PLANTER

This instrument is designed for planting at the required depth. The planter is inserted into the ground and pushed forward to release the seed potato, the hole being covered with soil by the operator's foot. (Illustration above.)

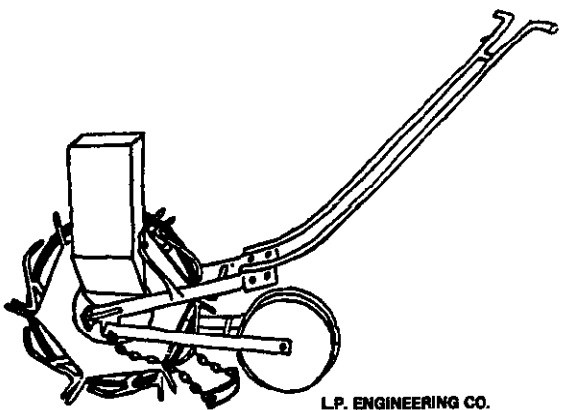
EARTHWAY PRODUCTS INC.
P.O. Box 547
Maple Street, Bristol, IN 46507
U.S.A.



TREE SEEDLING PLANTER

This hand-held seedling planter is used to transplant tree seedlings from the nursery bed directly into the ground at a permanent plantation site in such a way that the entire root system is covered by, and comes into contact with, the soil. (Illustration left.)

LÄNNEN TEHTAAT OY
Paperpot Department
27820 Iso-Vimma (Sakyla)
FINLAND



ROTARY INJECTION PLANTERS

Rotary injection planters are similar to jab planters. The seed or grain is held in a hopper and introduced into the soil by six punches mounted on a rotating planting wheel. The instruments described here are all manually operated with weights of around 25 kg, and are suitable for a variety of seeds and grains. The seeds are planted at the required depth with spacings determined by adjustments which can be made to the instrument. The performance of rotary injection planters varies according to seed type and nature of terrain, but a rate of ½ ha per hour for maize, for example, can be expected.

An advantage of rotary injection planters is the wide range of conditions in which they can be used, even when the soil is uncultivated and terrain rough. These planters can be recommended when minimal tillage is being practised and/or when efforts are being made to reduce soil erosion by planting rougher seed beds.

L.P. ENGINEERING CO.
Galloway Road
Bishop's Stortford, Herts.
U.K.

POYING'S WELDING SHOP
282 National Hi-Way
Bryy, Anos, Los Banos, Laguna
PHILIPPINES

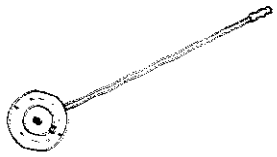
NDUME PRODUCTS LTD.
P.O. Box 62, Gilgil
KENYA

GEEST OVERSEAS MECHANISATION LTD.
Marsh Lane, Boston
Lincolnshire PE21 7RP
U.K.

MAHINDRA ENTERPRISES
507 Prince of Wales Avenue
Colombo 14
SRI LANKA

MBP ENGINEERING
KM 16 MacArthur Highway
Malanday, Valenzuela
Metro Manila
PHILIPPINES

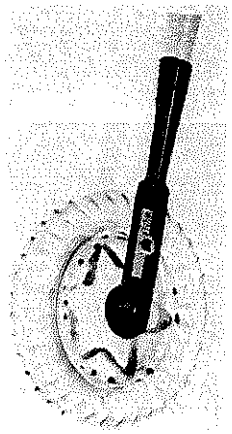
ELA AGRIC. MACHINERY MFG. AND ENGINEERING COMPANY
EB/914B Iwo Road, Ibadan
NIGERIA



PLANT-RITE ROW SEEDER

Earthway produced this hand-pushed garden seeder with the domestic market in mind, but it may have a wider application. Ideal for vegetable seeding it is light (1½ kg) and has a calibration dial which covers all common vegetable seed types.

EARTHWAY PRODUCTS INC.
P.O. Box 547
Maple Street, Bristol, IN 46507
U.S.A.

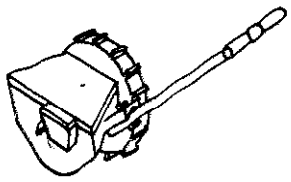


SEED SOWER

This instrument is similar to the Earthway model except that it can be used to plant a wider variety of seeds up to the size of a small pea.

WOLF TOOLS FOR GARDEN & LAWN LTD
Ross-on-Wye
Herefordshire HR9 5NE
U.K.

OUTILS WOLF
Rue de l'Industrie, 67160 Wissembourg
FRANCE

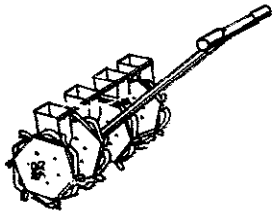


SAALET SEED DRILL

The Saalet Seed Drill is a modern all-purpose, hand-pushed seeder. It is able to line sow seeds ranging in size from parsley to beans and peas, and is equipped with 4 interchangeable seed dispensers, each with 8 holes.

Also included is a template by means of which the number of dispenser holes in use can be reduced from 8 to 4 or 2 with a corresponding increase in the distance between seeds.

ZINCK'S FABRIKER A/S
Godthaab, Jylland, 9230 Svenstrup
DENMARK



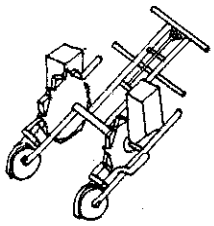
4-ROW PLANTER

The hand-pulled planter is intended for upland rice and gives a seed spacing of 25 x 25 cm. It is recomended only for upland soils which can be drained during seeding to provide air for germination.

GEEST OVERSEAS MECHANISATION LTD.
Marsh Lane, Boston
Lincolnshire PE21 7RP
U.K.

E.L.A. AGRICULTURAL MACHINERY MANUFACTURING AND ENGINEERING COMPANY
E9/914B Iwo Road, Ibadan
NIGERIA

MAHINDRA ENTERPRISES
507 Prince of Wales Avenue
Colombo 14
SRI LANKA



2-ROW PLANTERS

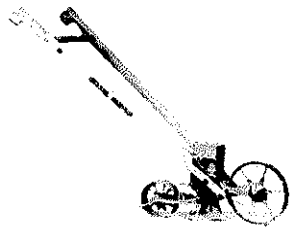
This rotary injection planter is hand-pulled and is used to plant seeds of groundnut, maize and smaller seeds at 25 cm spacing and at a depth of 5 cm. Row spacing of 80, 70, 60, 50 and 40 cm can be used, and in operation the two rows can be 'split' on the next pass to give spacings a half of these widths.

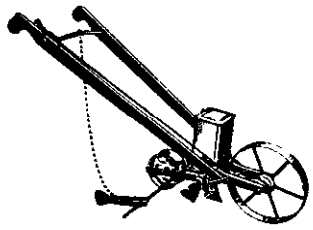
A simple device enables the seeding wheels to be lifted out of the ground at the end of the row so that the machine can be turned on the press-wheels.

PRATEEPKOLKARN
35 Charoenpun Road
T. Thai — IT, A. Muang, Uttaradit
THAILAND

A more sophisticated 2-row planter is also available from:

MAHINDRA ENTERPRISES
507 Prince of Wales Avenue
Colombo 14
SRI LANKA





SINGLE-ROW HAND SEEDERS

These hand seed drills are a little more advanced than a simple model such as the ASPEE APS-54. Although very similar in operation, having furrow openers, coverers, press and ground wheels, these seeders are equipped with interchangeable seed plates. The seed plates allow for adjustments to be made for a wide range of seed types. The actual seeding process is gravity fed from a mounted hopper from which the seeds are released by an agitator sprocket.

These models feature row markers and seed cut-offs, and weigh between 15-19 kg.

The Cossul model is illustrated above (top illustration).

The Tröster model is illustrated above (lower illustration). Manufacturers of similar machines are also listed below.

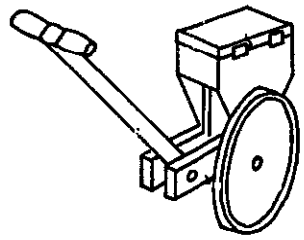
TECHNOHAC AGRICULTURAL MACHINERY & IMPLEMENTS LTD.
New Industry Region
Petakh-Tikva, P.O.B. 225
ISRAEL

A.J. TRÖSTER LANDMASCHINENFABRIK Gmbh & CO. KG
P.O. Box 240
6406 Butzbach
W. GERMANY

DALTON COOPER AND GATES CORP.
205 West 34th Street
New York, NY10001
U.S.A.

COSSUL & CO. PVT. LTD.
123/367 — Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

AMERICAN SPRING & PRESSING WORKS PVT. LTD.
P.O. Box 7602
Adarsh Housing Society Road
Malad, Bombay 400 064
INDIA



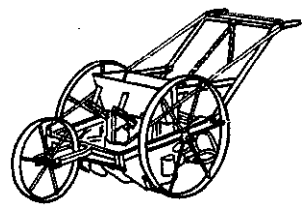
MANUAL SEEDER

This wooden seeder is designed for use with both cereals and legumes. Its use reduces the losses inherent in broadcasting seed and, because it sows in rows, enables weeding to be carried out more easily.

The seeder can be used with two alternative seed wheels either for wheat, lentils and small beans or large beans. A butterfly nut fastens the adjustable seed outlet. The seeder can also be used to dribble fertilizer along row crops.

This design was developed by Roger Mourier from a traditional design which has been in use in the Concepcion region of Chile for the last 50 years. This model can be purchased from the fabrication workshops of GIA, who will also supply plans for local manufacture.

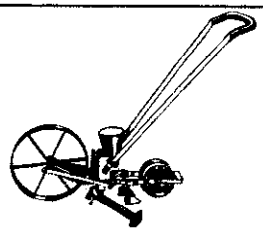
G.I.A.
Ricardo Matte Pérez 0324
Casilla 6122, Correo 22
Santiago
CHILE



TROPIC RICE SEEDER

The Tropic Rice Seeder, developed in the Cameroun, is a sturdy, hand-pushed instrument suitable for upland soil conditions. It is equipped with a large hopper capacity and three sowing furrow blades.

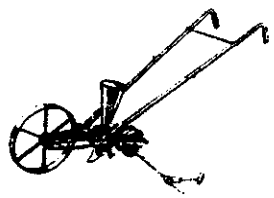
TROPIC
B.P. 706
Douala
CAMEROUN



HAND SEED DRILL

This is a very simple hand-pushed seed drill used for line seeding in dry fields. Suited for smallholder farmers, it can be used for a wide range of seeds such as jute, wheat and rice.

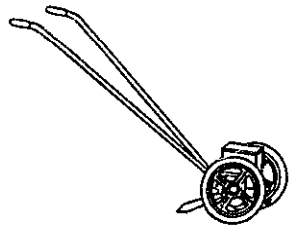
WEST BENGAL AGRO-INDUSTRIES CORPORATION LTD.
23B Netaji Subhas Road
3rd Floor
Calcutta 700 001
INDIA



SEED DRILL AND WHEEL HOE, APS-54

The APS-54 model is a light (15 kg) hand-pushed, manually fed, line seeder which can be used for small seeds such as jute, linseed, mustard and wheat. Once drilled, the seeder covers and packs the soil to aid germination.

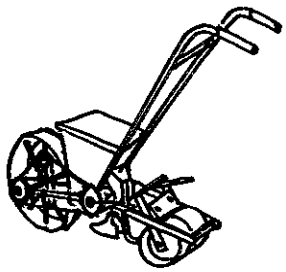
AMERICAN SPRING & PRESSING WORKS PVT. LTD.
P.O. Box 7602
Adarsh Housing Society Road
Malad, Bombay 400 064
INDIA



EXEL HAND SEEDER

Designed for most types of vegetable seed, this hand-pushed seeder is suitable for small areas of well-prepared land. The two rubber-tyred wheels drive the seeding mechanism which is supplied by a one-litre capacity hopper.

RUSSELLS (KIRBYMOORSIDE) LTD.
Kirbymoorside
Yorkshire YO6 6DJ
U.K.



MULTI-PURPOSE PRECISION SEEDER

EBRA produce 2 hand seeders (Type XJ1 and Type XJ2) suitable for market gardens or smallholdings. They can be used for almost any seed or grain type.

The XJ1 model, shown here, can sow singly in lines or in multi-seed hills. It has 2 distributors for small and medium seeds, and a chain-driven seeding mechanism with changeable chain wheels for different seed spacings. The seed hopper has a 5-litre capacity and the furrowing blade can be adjusted to the required planting depth. The XJ1 is also fitted with adjustable covering blades and a weighted roller. In addition this seeder can be supplied with other seed distributors and a row marker extendable to 60cm. There is also a XJ2 model with a disconnector for the seed distributor.

E.B.R.A.
28 Rue du Maine
B.P. 915, 49009 Angers Cedex, France

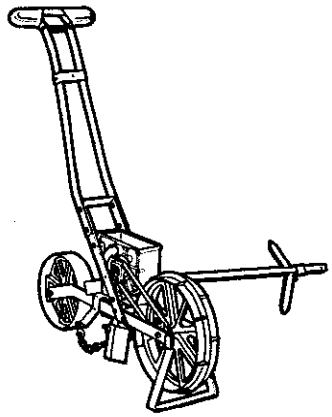
PRECISION HAND-SEEDER AND FERTILIZER DRILL

Precision seeders can be used to plant a wide variety of vegetable seeds through six easily interchangeable seed plates which regulate the seed flow from the hopper to the planting mechanism. The seeder when in use opens the soil, plants the seeds at the desired spacing and depth, and covers the seeds while marking the adjacent row.

An additional and optional feature of this seeder is a fertilizer applicator for side dressing. It allows for a calibrated application of granulated fertilizers next to the seed row being planted at the required depth up to 5 cm.

EARTHWAY PRODUCTS INC.
P.O. Box 547
Maple Street, Bristol, IN 46507, U.S.A.

LAMBERT CORP.
519 Hunter Avenue, P.O. Box 66
Dayton OH 45405, U.S.A.



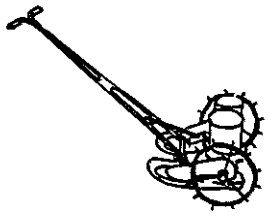
'CECOCO' HAND DIRECT SEEDERS

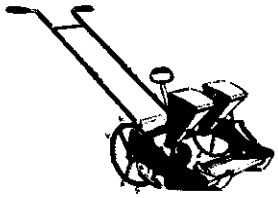
These light and compact (12 kg) 2-row seeders can be operated either on wet field conditions (Type CK-AW), or in dry field conditions (Type CK-AD). The difference between the two is that for dry field conditions, the sleds are replaced by furrow opener attachments.

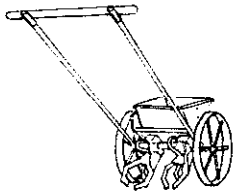
A wide variety of seeds and grains may be used, these being planted at regular intervals by a brush mechanism, the position of which can be adjusted according to the desired quantity and size of seed to be planted. Also adjustable are the seeding intervals and widths. In both models seed is supplied from two 2.2 litre hoppers.

An extra feature of the CK-AD hand seeder is a 5 kg fertilizer hopper (Type CK-M) for the application of granular fertilizer as well as seed.

CECOCO, P.O. Box 6
Ibaraki City, Osaka Pref. 567
JAPAN







'CASAMANCE' RICE SEED DRILL

This type of hand-pushed, 2-row rice seed drill is equipped with 2 x 25 cm sowing ploughshares. The distributors are mounted on the wheel axles and can be adjusted for up to 130 seeds per meter.

SISMAR
B.P. 3214
20 Rue Dr. Theze
Dakar
SENEGAL

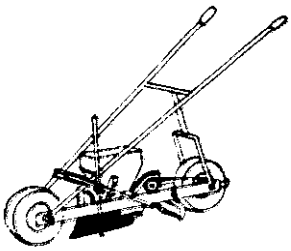
ANNAPURNA SEED CUM FERTILIZER DRILL

The Annapurna Seed Drill can be used for all types of seeds and granular fertilizers. It is quite a bulky instrument which in light soils requires 2 people for operation, while in heavier or water-logged conditions animal draught would be needed.

By means of a double action mechanism, the fertilizer is placed 7 to 10 cm deep in the ground and covered by 5 cm of soil. The seed is then sown and in turn covered by 2.5 to 5 cm of soil. Row spacing can be adjusted to 15, 22.5 and 30 cm for up to 3 rows.

The equipment is manufactured from steel and wood, and has a total weight of 23 kg. Seed hopper capacity is 3 kg, while that of fertilizer is 5 kg. Depending on seed type, 1-1.5 hectares can be sown in one day.

ANNAPURNA TRANSPLANTERS
62 Suryanagar
Bhubaneswar — 751003, Orissa
INDIA



PRECISION HAND-SEED DRILLS

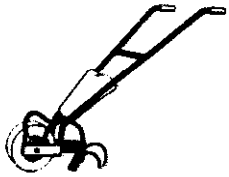
These quite sophisticated hand-seed drills can be used for a wide range of vegetable seeds. They are designed in a way that keeps seed wastage to a minimum and allows great precision in planting depth and seed spacing to promote faster germination.

The Mini-Nebex from Sweden will take both natural and pelleted seed for which there are 25 types of interchangeable cup available. It has a seeding rate which can be varied from 4 to 2,000 seeds per running metre, either thin line or band drilled, and an overall performance of up to 0.8 hectares per day.

The Hestair Stanhay seeder is similar to the Mini-Nebex but features a seeding mechanism which employs a perforated belt to give the required seed spacing and pattern. The belts are easily interchangeable and are used according to seed type.

HESTAIR FARM EQUIPMENT EXPORT LTD.
Ewing, Newmarket, Suffolk CB8 7HD
U.K.

MIBE-VERKEN Ab.
P.O. Box 14, S-285 00 Markaryd
SWEDEN



FLOWSOW SEED DRILL

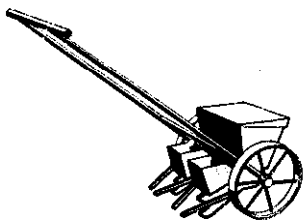
The Flowsow Seed Drill is a novel instrument developed for the purpose of sowing seeds using a suspending fluid (gel) as a carrier instead of the more usual belts, chains, plates or cups. The main advantage of using the gel carrier as opposed to dry seeding is that all the seeds are planted in the same environment ensuring even emergence, and that the seeds will not be exposed to such wide moisture fluctuations in the soil. The use of a suspending fluid also permits the sowing of pre-germinated seeds.

The gel is simply prepared by mixing with water and leaving to stand for 20 minutes. The seeds are stirred in well, and then by taking a 5 ml sample, the average density of seeds can be calculated. As the drill delivers 5 ml of gel for every 135 mm of wheel travel (regardless of wheel speed), the required density of seeds in the gel can be achieved so that the seeds are then sown at the correct spacings.

The use of a liquid sowing medium enables even very small and irregularly shaped seeds to be distributed into the soil at the required spacing. Use of the gel also enables precise placement, close to the seeds, of additives such as pesticides, fungicides and fertilizers. These substances can be added to the gel at the seed-mixing stage and extruded together with the seeds.

The hopper has a capacity of 2.25 litres (sufficient gel to cover 100 m travelled by the drill) and the drill can sow seeds up to 8 mm in diameter. Overall weight is 10 kg.

FLOWSOW ENGINEERING CO.
Sides, Silverhill
Robertsbridge, Sussex TN32 5PA
U.K.



RICE SEED DRILL

This hand-pushed rice seed drill is essentially the same as that manufactured by Sismar, above. The MARPEX model shares similar specifications and weighs about 31 kg.

MARPEX
1 Rue Thurot
44000 Nantes
FRANCE

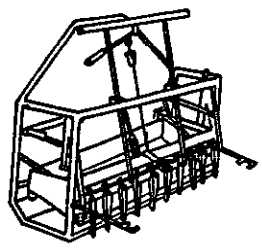
ANNAPURNA PADDY TRANSPLANTER (Model 77)

This unusual hand-operated paddy transplanter was developed at Orissa University, Bhubaneswar, in India. Field tests claim a relatively trouble-free performance, significantly faster than the human hand. The machine levels and compacts the puddle, buries any floating weeds in the mud, and plants seedlings at a uniform spacing and depth (2.5 cm).

The transporter works best with rice seedlings 20-25 days old or 10-25 cm in length. It is also able to function efficiently in a wide range of soil conditions, but shallow (10-15 cm) soft, settled puddle with 1-3 cm of standing water is ideal.

The transplanter is constructed of steel with wood fittings and weighs about 16 kg. An advantage in the design is its ease of maintenance, nuts and bolts needed being available from bicycle repair shops, and spare parts being easily fabricated locally.

A comprehensive manual of operation is supplied with the transplanter. This includes a list of limitations which point out that performance will not be more than 0.25 hectares per 8 hours, and that unless seedlings are tender and both puddle and standing water shallow, operation will prove to be difficult.



ANNAPURNA TRANSPLANTERS
62 Suryanagar
Bhubaneswar — 751003, Orissa
INDIA

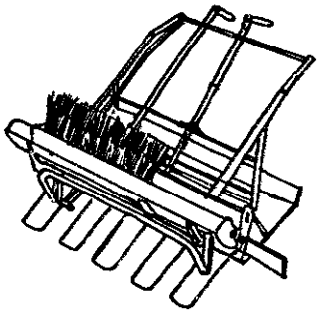
MAN-POWERED RICE PLANTER

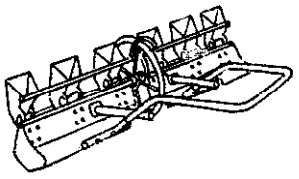
Size of machine 1 x 1.2 x 0.7m
Working width: 0.96 m
Weight: 24 kg
Number of rows: 6
Row spacing: 150 m
Seed spacing: Adjustable to need
Damaged seedlings: 5%
Manpower: 2-3 persons

To operate this rice transplanter the soil must be even, the water depth for large seedlings being 20-50 mm, for small seedlings 10-25 mm. Large seedlings are classified as 150-300 mm with roots less than 40 mm deep, small seedlings are classified as 60-150 mm with 15-20 mm soil. Seedlings are 8-10 days old.

Manufactured by: NONG NI RICE PLANTER FACTORY, and available through:

CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing
CHINA

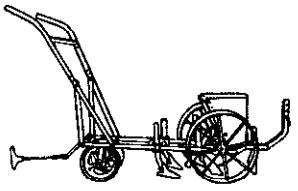




PADDY ROW SEEDER

This paddy row seeder is a manually operated (2 person) machine, weighing 20 kg, and having a performance of 50 kg per hectare in 5 to 7 hours. Up to 6 rows can be seeded at any one time, each row supplied by an individual hopper.

METAL INDUSTRIES DEV. CENTRE
Jalan Sangkuriang 12
P.O. Box 113, Bandung
INDONESIA



SINGLE-ROW, MULTI-PURPOSE SEEDERS

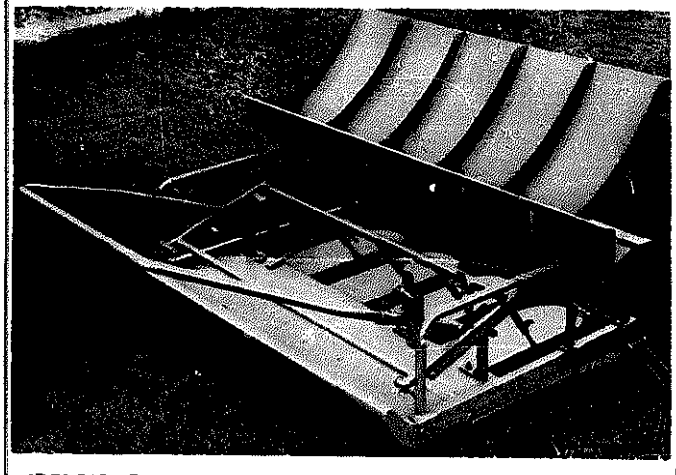
The model illustrated here is produced by SMECMA of Mali and is suitable for planting seeds of groundnut, millet, sorghum, maize, rice and cotton. The distribution is powered by a direct drive mechanism through the main wheels and achieved by inclined seed plates which can be changed to adjust the seed spacing in the row.

There are in fact 3 seed plates supplied with the seeder which give spacings of 15, 25 and 32 cm respectively, although the manufacturer will supply other sizes on request.

Other features of the drill are a 10 litre hopper, adjustable sowing ploughshare, double covering coulter blades,m a 20 cm diameter roller and an adjustable row marker. A very similar model of the animal-drawn, single row, multi-purpose seeder is available from Marpex.

S.M.E.C.M.A.
B.P. 1707, Bamako
MALI

MARPEX
1 Rue Thurot, 44000 Nantes
FRANCE



IRRI RICE TRANSPLANTER

This manually operated rice transplanter developed by the International Rice Research Institute is a simple, easily operated and maintained machine which is able to cover 0.25 hectares per day. The machine is operated by one person and can be fabricated in small workshops using readily available local materials.

Power: 1 person
Field capacity: 0.25 ha/day
Labour requirements (1 ha):
Seedling production: 30-35 man hours
Transplanting: 70 x 35 man hours
Number of rows and spacing: 5 at 20 cm
Planting depth adjustment: 2 to 5 cm
Field standing water depth: 1 to 10 cm
Seedling age: 15 to 30 days
Weight: 25 kg
Length: 120 cm
Width: 116 cm
Construction: Steel and wood

POYING'S WELDING SHOP
282 National Hi-Way, Brgy. Ance
Los Banos, Laguna
PHILIPPINES

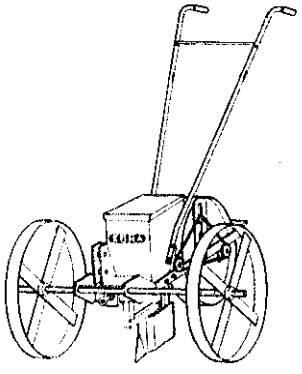
PETE LIM'S ENTERPRISES
San Francisco, Agusan del Sur
PHILIPPINES

JCCE INDUSTRIES
242 Mayondon
Los Baños, Laguna
PHILIPPINES

MBP ENGINEERING
KM 16 MacArthur Highway
Malanday, Valenzuela
Metro Manila
PHILIPPINES

JINASENA LTD.
P.O. Box 196, Colombo
SRI LANKA

LIGHT ENGINEERING INDUSTRIES
127 Kottawa Rd, Nugegoda
SRI LANKA



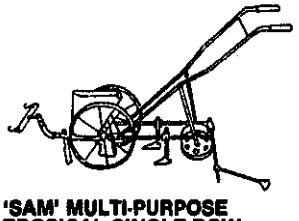
PRECISION PLANTER MS 2TA

This animal-drawn, single row planter can sow any grain with the correct disc plate available from the manufacturer.

An unusual feature of the planter is the front axle arrangement by which the width between the front wheels can be adjusted. Also adjustable is the rear wheel chain drive and the shoe coulter planting depth. The seed spacing can be varied along with the row with 6 interchangeable sprocket wheels.

An optional extra is covering-up scrapers which are useful under hard conditions. In such cases it may be necessary to help the rear (press) wheel covering action by fitting, between the shoe coulter and press wheel, the 2 covering-up scrapers which throw the earth back on to the seed row.

E.B.R.A.
28 Rue du Maine, B.P. 915
49009 Angers Cedex
FRANCE



'SAM' MULTI-PURPOSE TROPICAL SINGLE ROW SEEDER

The 'Sam' animal-drawn seeder is very similar to the SMECMA model described above. It also is suitable for groundnut, millet, maize, sorghum, cotton and other seeds. The seeder weighs about 40 kg.

ARARA
30 rue d'Anjou, 7800 Versailles
FRANCE

MX1 ANIMAL-DRAWN SEEDER

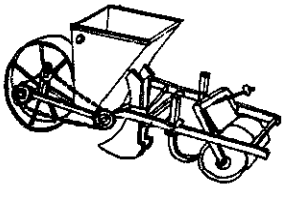
The light-weight, animal-drawn, single row seeder is equipped with a multi-purpose distributor on an inclined plate. This is linked with interchangeable chain wheels which vary the seed spacings.

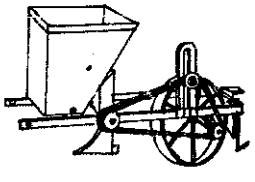
The shoe is adjustable to control depth, as are the two covering coulter blades. To the rear of the main assembly is a 140 mm diameter, concave faced, weighted roller.

This machine is a precision seeder which gives exact control over planting depth and minimises seed loss and sticking.

Also available is the MX2 row seeder (lower illustration). This is essentially the same as the MX1 but forms a double unit with special couplings for draft purposes.

E.B.R.A.
28 Rue du Maine, B.P. 915
49009 Angers Cedex
FRANCE

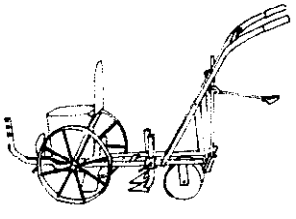




SUPER ECO/TAMBA SEED DRILL

The super Eco/Tamba multi-purpose, single row seed drill is equipped with 2 different hoppers which may be used for all types of seed. The Super Eco Hopper is designed for a wide range of seeds including groundnut, millet, sorghum, maize, beans, rice, etc. Its drive is powered by the two large front wheels and the seeds distributed by interchangeable discs which are available on request from the manufacturer. The Tamba Hopper is more specialised and is designed for undelinted cotton seed. Five or 6 seeds are sown together in each seed hole, the spacing being adjustable between 15 and 25 cm. The feed is pinion and chain agitated, and the distribution achieved by notched discs mounted on the wheel axle.

The actual seeder frame has an adjustable sowing ploughshare and covering coulters, a seed press wheel and bar screw coupling.



SISMAR
B.P. 3214
20 Rue Dr. Theze
Dakar
SENEGAL

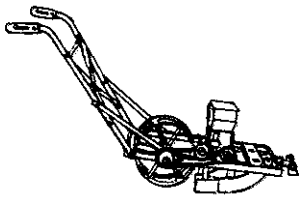
SEBELE SINGLE-ROW PLANTER

The Sebele single-row planter, manufactured in Botswana, is equipped with a seed metering mechanism which operates by the 'gravity drop' principle. The seed falls through a pre-selected hole in a stationary metering plate, and a chain-driven agitator in the seed hopper keeps the seed flowing steadily.

The seed then drops between the two coulter plates in view of the operator who is able to determine if it is planting regularly.

The planter can also be fitted with a four-rate adjustable fertilizer applicator. This feature can be extended so that the planter can be used as an inter-row cultivator. In this way fertilizer can be top-dressed at the time of inter-row cultivation.

The planters work best on good, well prepared seed beds, and farmers should not try to plant 'to a stand'; not every seed will germinate and, if necessary, thinning should be practiced.



CLIFF ENGINEERING
Box 282, Gaborone
BOTSWANA

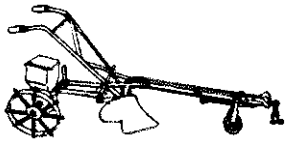
RURAL INDUSTRIES INNOVATION CENTRE
Private Bag 11, Kanye
BOTSWANA

SEBELE PLOUGH PLANTER

The Sebele Planter is a device which may be attached to single or double furrow ox ploughs, or tractor ploughs (when a small electric motor is needed to drive the agitator).

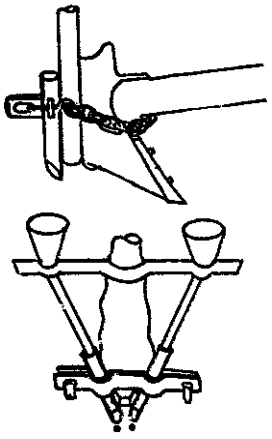
The single row seeding mechanism operates by gravity drop and is suitable for nearly all seed types, cereals, pulses and groundnuts alike. The seeding is by dribble feed (not uniform) and is controlled by a selection of circular metering plates. The agitator is of the 'wavy' edge, disc type, and is driven by an 8-spoke wheel. The plough planter also has a seed cut-off mechanism and hopper with 2-3.5 kg capacity depending on seed type.

The weight is about 11 kg which includes a single furrow ox plough bracket.



CLIFF ENGINEERING
Box 282, Gaborone
BOTSWANA

RURAL INDUSTRIES INNOVATION CENTRE
Private Bag 11, Kanye
BOTSWANA

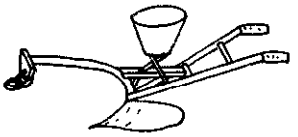


SEED AND FERTILIZER DRILL FOR VILLAGE PLOUGH

This device is a simple piece of equipment which can be attached to an ox/animal-drawn village plough. The drill places the fertilizer in the soil at the correct distance away from the seed. This is achieved by means of a wooden frame on top of which are mounted 2 small hoppers. From the hoppers the fertilizer and seed are dropped through two tubes (forming part of the frame) into the plough furrow. Without spanners, simple adjustments can be made to the frame to vary the distance between seed and fertilizer.

This is a very basic piece of equipment which has the advantage of being very easily maintained, robust, and adaptable to any village plough.

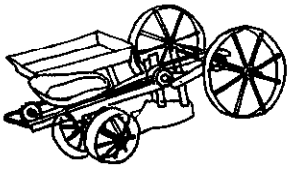
MEDAK AGRICULTURE CENTRE (EQUIPMENT)
Cathedral Compound, Medak
Andhra Pradesh 502 110
INDIA



SEED CUM FERTILIZER DRILL MEC-501

This animal-drawn device is similar to a plough planter and has been used, according to the manufacturer, successfully in large and small areas. Further details are available from Modern Engineering.

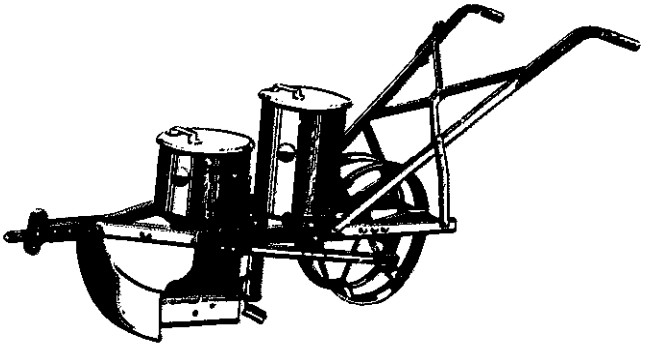
MODERN ENGINEERING COMPANY
1A Anna Street, Velandi Palayam
Coimbatore 641 025, Tamil Nadu
INDIA



UNIVERSAL PLANTER

The animal-drawn single-row planter can be adapted, through a wide range of fittings, to handle all types of seeds, seedling and tuber distribution. Overall weight of the planter is 8.5 kg.

ETS. CARRÉ
85140 Saint Martin-des-Noyers
FRANCE



PITMAN DRIVE SINGLE-ROW PLANTERS

These single-row planters are of simple and rugged construction, light to handle and easy to operate. The planter carries out precision seeding by means of a double Pitman drive, one from each side of the main wheel. The seed box unit (hopper) is designed to handle a large variety of seeds by selection of appropriate seed plates. Seed spacing in turn is determined by the number of holes on the seed plate in use. The fertilizer attachment, which is usually an optional extra on Pitman planters, can handle all types of granular fertilizer, the gate opening being constructed to give a wide range of adjustments. Also available, where required, is a cotton planting attachment. The number of seed plates available for Pitman planters is a special feature. Standard plates are available for all of the more usual crops, and undrilled plates can be ordered for special requirements. Overall weight is around 64 kg.

AGRIMAL (MALAWI) LTD.
P.O. Box 143, Blantyre
MALAWI

BAIN MANUFACTURING COMPANY (PVT.) LTD.
Box 1180, Harare
ZIMBABWE

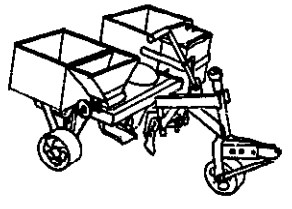
BULAWAYO STEEL PRODUCTS
6 Ironbridge Road, Donnington
P.O. Box 1603, Bulawayo
ZIMBABWE

ZIMPLOW LTD.
HS Steelworks Road
Box 1059, Bulawayo
ZIMBABWE

ANIMAL-DRAWN SUGAR CANE PLANTER

The IISR single-row, animal-drawn sugar-cane planter is useful for flat planting of three budded sugar cane setts in light soils. Two people are needed for the operation, one to guide the implement or animal(s), the other to feed manually the sugar cane setts. As the implement moves forward a furrow is opened and the operator riding on the fore-carriage picks up setts from the seed boxes and drops them singly into the feeder chute. A crop protection agent is sprinkled over the planted setts and soil surface by gravity flow, while fertilizer is placed in 2 bands and covered by soil. Finally the seeded row is compacted by a free roller.

The weight of this planter is about 70 kg with a performance of 0.2 ha/hr.



INDIAN INST. OF SUGAR CANE RESEARCH
AGRI. ENG. DIV.
Lucknow 226 002, U.P.
INDIA

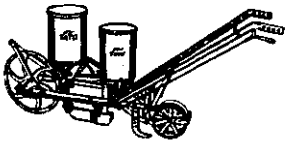
'TATU' ANIMAL TRACTION PLANTING SYSTEM STP-TA

This seed and fertilizer drill is designed for cereal planting. Seed and fertilizer distribution are independent and driven by a chain transmission from the front wheel. There is a manually operated coupling and uncoupling device for the distribution system to avoid seed wastage during manoeuvres at row ends.

Seed distribution is achieved by a seed plate which can be adjusted with a series of 'keys' according to individual seed type spacing requirements. The advantage of this system is that it avoids damaging the seed plate by removal and remounting.

The seed planting depth is also adjustable by means of a notched lever mounted on the rear compacter wheel.

The planter weighs about 60 kg, and is able to carry 23 kg of fertilizer and 14 litres of seed.



MARCHESAN IMPLEMENTOS E MÁQUINAS AGRÍCOLAS TATU S.A.
C.P. 131, 15990 Matão SP
BRAZIL

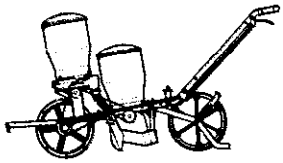
BALDAN IMPLEMENTOS AGRÍCOLAS S.A.
Av. Baldan 1500, C.P. 11
15990, Matão S.P.
BRAZIL

J1-S PLANTER FERTILIZER

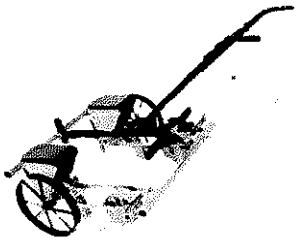
This single-row planter is used for sowing seeds of corn, beans, rice, cotton, sunflower, etc. The unusual feature of this machine is that, as well as performing conventional seeding and fertilizing operations, it can be adapted to form a system for the simultaneous planting of two crops (e.g. corn and beans). Certain advantages can be gained from this method. In the case of simultaneous corn and bean planting, the farmer could expect a reduced risk of crop damage by disease and weeds, better soil erosion control and an increased yield stability.

For conventional planting the dual planting system can be removed.

Seed distribution is achieved through interchangeable, perforated seed plates which are chain-driven from the front wheel, while that of fertilizer is controlled by the hopper's rotation movement. A manually operated cut-off reduces seed and fertilizer losses during manoeuvres.



JUSTINO DE MORAIS IRMÃOS S.A.
Rua Ana Luiza 588, C.P. 75
14.300 Batatais S.P.
BRAZIL



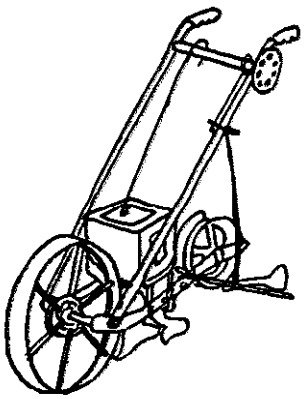
PRECISION SEEDER

Rau have produced this seeder for the planting of nearly all types of cereal, bean, cotton and vegetable seed.

Seed plates (interchangeable) have to be selected according to the type of crop being sown.

The working depths of the furrow openers are adjustable as are the track markers. Row spacing can be varied between 30 and 100 cm.

RAU MASCHINENFABRIK GmbH
Johannes-Rau-Straße
7315 — Weilheim an der Teck
W. GERMANY



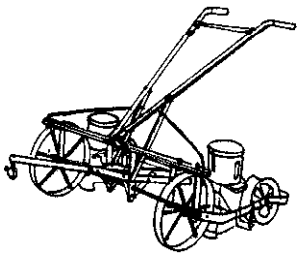
SUGAR BEET AND VEGETABLE SEEDER

This seeder is equipped with furrow openers, coverers, press wheels and ground wheels. Also included is a mechanism which engages and disengages the seeding mechanism.

The seeder is supplied with 3 interchangeable seed plates (total of 39 holes) and is able to handle a complete range of seed types.

TECHNOHAC AGRICULTURAL MACHINERY & IMPLEMENTS LTD.
New Industry Region
Petakh-Tikva, P.O.B. 225
ISRAEL

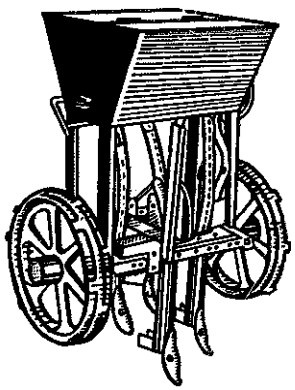
2-ROW SEEDERS



ANIMAL-DRAWN COTTON SEEDER

Designed by Technohac for the smallholder wishing to plant undelinted cotton. The planter is equipped with furrow openers and seed coverers, while the press wheel is constructed of 2 halves, each covered with flexible rubber in an attempt to avoid clogging on damp soil. The 2 kg capacity hopper is fitted with a seed agitator continuously operating while the planter is in motion. Row spacings are fully adjustable from 30-96 cm.

TECHNOHAC AGRICULTURAL MACHINERY & IMPLEMENTS LTD.
New Industry Region
Petakh-Tikva, P.O. B. 225
ISRAEL

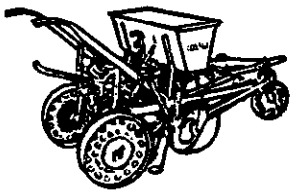


EICHER SEEDER

This machine is an Indian-made, 2-row, animal-drawn seeder. Features include a large hopper capacity and seed coverers.

EICHER GOODEARTH LTD.
Deepak 3rd Floor
13 Nehru Pl., New Delhi, 110019
INDIA

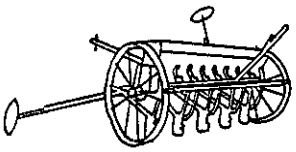
MULTI-ROW SEEDERS



AUTOMATIC SEED DRILL

Cossul produce 2 models of this seed drill, the 3-row and 5-row, with weights of 94 and 110 kg respectively. The machine is provided with disc furrow openers and fluted feed rolls. Row spacings are adjustable from 150-250 mm.

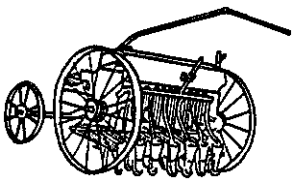
COSSUL & CO. PVT. LTD.
123/367 — Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA



SEMINATRICE SEED DRILL

This animal-drawn seed drill is equipped with 5 row seeders, openers operated by thrust arms, with cast-iron force-feeders, seed-rate adjuster, depth of sowing lever and outlet release. Seed distribution is achieved by feed cups of which there are 9; this allows for a wide range of possible seed types to be planted.

NARDI FRANCESCO & FIGLI
06017 Selci Lama, Perugia
ITALY



S-012 and S-014 ANIMAL-DRAWN SEED DRILLS

These seed drills are designed to take most kinds of cereals, leguminous crops, oily crops and other types of seeds. The seeding mechanism is driven from the ground wheels through a geared transmission system. Depending on the seed to be sown, the mechanism can either be set 'low' or 'high'.

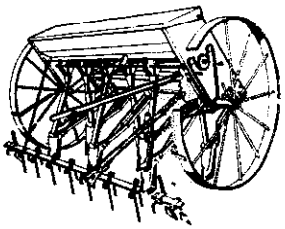
Row spacing (10-60 cm) can be easily adjusted at the rear of the seeder after which the front wheel track should be set.

The seeding mechanism can be quickly disengaged during manoeuvres by means of a single lever. This raises the coulters and disengages the drive — a feature also useful for transportation purposes.

Manufactured by: AGROMET KRAJ, and available through:

AGROMET MOTOIMPORT
Foreign Trade Enterprise
Przemysiowa 26
P.O. Box 990, Warsaw
POLAND

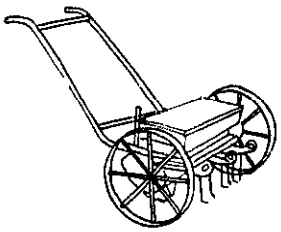
MULTI-ROW SEEDERS



MARPEX MULTI-ROW SEEDER

This is a large and complex animal-drawn seeder which can be used to plant all varieties of rice, wheat, etc. It offers the operator 4-7 seeding rows which may be adjusted for spacings of between 20 to 40 cm. Seeding is achieved by a force-fed rolling distribution system with an adjustable flow.

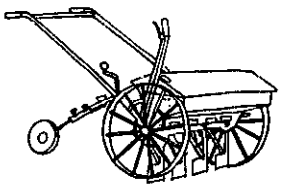
MARPEX
1 Rue Thurot, 44000 Nantes
FRANCE



'KOLDA' RICE SEED DRILL

Suitable for all varieties of rice seed, this seed drill may be either man- or animal-drawn. The machine features 3 seeders at 25 cm spacing, a grooved seed distributor and adjustable flow.

SISMAR
B.P. 3214, 20 Rue Dr. Theze, Dakar
SENEGAL

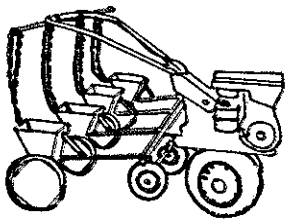


NODET 'MOPTI SA9' SEED DRILL

Essentially a larger version of the Sismar 'KOLDA' Seed Drill, this implement can be used to plant all varieties of rice of wheat seed. It is equipped with 4 or 7 rows with spacings of between 20 and 40 cm. As with the 'KOLDA', seeding is by grooved distributors with adjustable flow.

SISMAR
B.P. 3214, 20 Rue Dr. Theze, Dakar
SENEGAL

MULTI-ROW SEEDERS

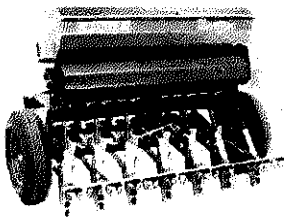


MULTI-UNIT PRECISION SEED DRILL

This all-steel seed drill can be used to plant any kind of seed.

The seeding mechanism is a brush running over a nylon cell wheel at the base of the hopper directly above an adjustable sowing coulter. Each cell wheel covers one grade seed size and requirements should be stated when ordering this machine. A useful feature of the machine is that it can be ordered in single hand-pushed units or any multiple of this depending on draught power available to the farmer.

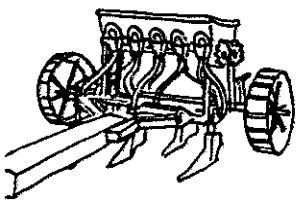
ALVAN BLANCH DEVELOPMENT CO. LTD.
Chelworth
Malmesbury SN16 9SG, Wilts.
U.K.



FIONA SEED DRILL 1.5m

This quite sophisticated seed drill is equipped with traces for animal draught. It is able to sow up to 6 rows, the desired sowing quantity being adjusted simply by one gear lever. Additionally, a special 3-finger attachment can reduce the quantity being sown by up to 65%. The hopper can also be fitted with individual seed containers for row crop work involving small seeds. Extra wings can be fitted on the sowing axle, without the aid of tools, to ensure a continuous flow of difficult seeds into the seed cup.

SCHEBY MASKINFABRIK
5400 Bogense
DENMARK



JYOTI SEED AND FERTILIZER DRILL

The seed and fertilizer drill is able to handle a wide range of seed types from small varieties such as mustard through to maize. Metered fertilizer and seed are applied simultaneously. Row widths can be varied from 20 cm to 90 cm.

JYOTI LTD.
Bombay Shopping Centre
R.C. Dutt Road, Vadodara 390 005
INDIA

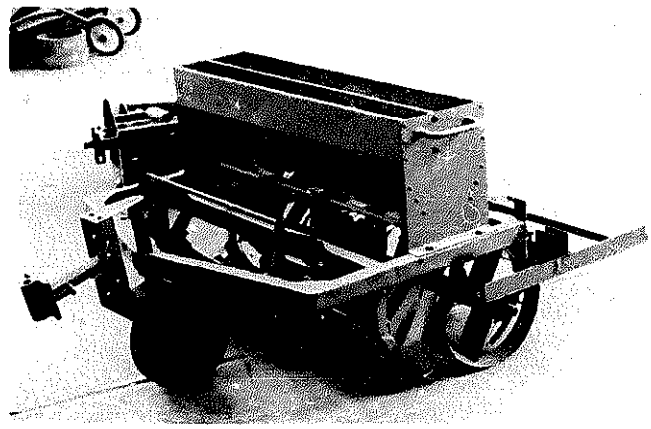
IRRI MULTI-CROP UPLAND SEEDER

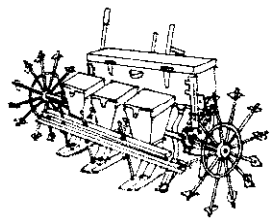
This is equipped for up to 5 rows at 20 cm spacing with a fertilizer application facility. Suitable for a wide range of seed including rice, sorghum, soyabean, corn and mungbean, it can plant 2 crops simultaneously.

The seeder can be drawn by either a 6.8 hp tiller or by animals and requires only one operator. Sowing coulter depth can be adjusted and seed plates changed according to type of seed being shown.

The machine's hopper capacity (per row) is 2.5 kg for rice seed, 3.3 kg for fertilizer. These feed the seeding mechanism through seed plates allowing variable seed spacings of 20, 25 and 50 cm. Row spacing adjustable from 20 to 90 cm. With experience the seeders' performance can reach up to 1.2 hectares per day.

JCCE INDUSTRIES
242 Mayondon, Los Baños, Laguna
PHILIPPINES

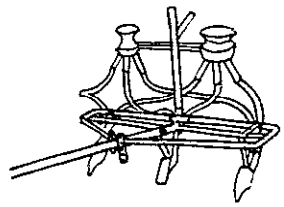




KRUSHI UDYOG JYOTI SEED AND FERTILIZER DRILL

A 3-row seed and fertilizer drill using 2 bullocks. Adjustable row spacing (22-44 cm), seed spacing and planting depth. For groundnuts and most cereal crop seed.

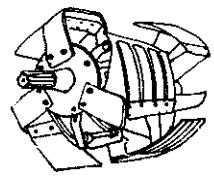
DEV. MAHARASHTRA AGRO. IND. CORPORATION LTD.
Rajan House, 3rd Floor
Near Century Bazaar, Prabhadevi
Bombay 400 025, INDIA



2 BOWLED SEED-CUM-FERTILIZER DRILL

This is a 3-row, animal-drawn implement. Similar in principle to the simple hand-seed drills, it requires two operators. The frame is all-steel with plastic feeder tubes from the bowls to the coulters.

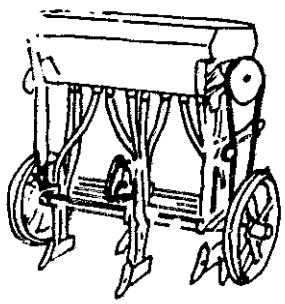
DEV. MAHARASHTRA AGRO IND. CORPORATION LTD.
Rajan House, 3rd Floor
Near Century Bazaar, Prabhadevi
Bombay 400 025
INDIA



GREEN MANURE BURYING TILLER MODEL MQ-51

This is powered by a 2-wheeled tractor and buries a 51 cm swathe of green crop up to 17 cm deep. The tiller pulverises the top soil, after burying the crop, making it ready without further tillage for cotton seeding. Manufactured by DONG THAI FARM EQUIPMENT, and available through:

CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing, CHINA



3 ROW SEED-CUM-FERTILIZER DRILL

This type of bullock-drawn seed and fertilizer drill is able to drill seed and fertilizer simultaneously at a rate adjusted to the crop requirements. It is suitable for most kinds of seeds including soya bean, all cereal crops and other smaller seed varieties. Depth of planting can be varied from 5 to 12 cm, as can row spacing, and an output of 1.5 hectares per day can be expected from experienced operators. The seeding and fertilizer mechanisms are chain-driven from one of the wheels. It requires the draught of 2 bullocks and needs one operator.

MOHINDER & CO. ALLIED INDUSTRIES
Kurali, Distt. Ropar, Punjab
INDIA

INTERNATIONAL MFG. CO. (REGD.)
Hospital Road, Jagraon
Ludhiana, Punjab
INDIA

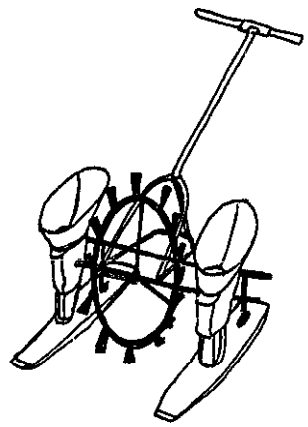
DEEP LEVEL FERTILIZER APPLICATOR

The implement is manually operated and designed for the deep level application of chemical fertilizers to such crops as wheat and rice. This method of fertilizing is good for optimizing the overall effect of the chemical.

Characteristics:
Number of rows: 2
Row spacing: 16-23 cm
Application depth: 3.3-6.6 cm
Capacity: 75-187 kg/hr
Hopper capacity: 2 × 2 kg
Fertilizer diameter (Granular) 12-14 mm
Output: 0.1-0.2 hr
Total weight: 6.5 kg

Manufactured by: YONG-TAI AGRICULTURAL MACHINERY, and available through:

CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing
CHINA

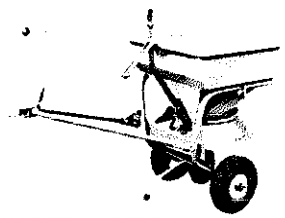


BALL FERTILIZER PRODUCTION MACHINE

This manufactures ammonium carbonate fertilizer balls for deep level application and can produce 14 mm diameter, 1 g balls at 200 kg/hr.

Manufactured by: MIN HOU AGRICULTURAL MACHINERY, from:

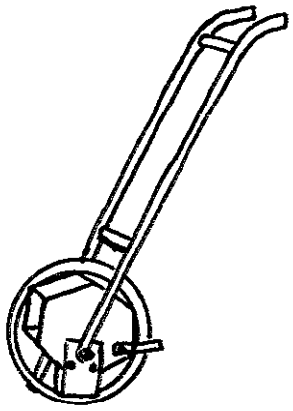
CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing, CHINA



KOMET 50 FERTILIZER SPREADER

This can spread granulated fertilizers over an adjustable arc of 1 to 7 m in width. Normally pulled by hand, it can be attached to a small 2- or 4-wheeled tractor (as illustrated). Capacity is 5.5 litres, width 56 cm.

RAUCH LANDMASCHINENFABRIK GmbH, Postfach 1107
7573 Sinzheim, W. GERMANY

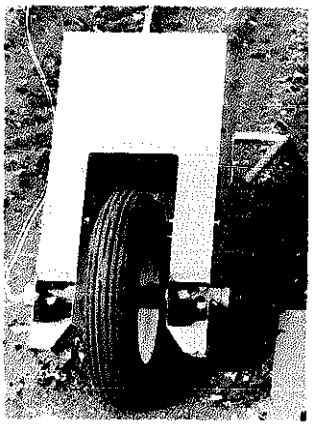


MAGRO FAB

The FAB (Fertilizer-Applicator-Band) dibbles a line of fertilizer at rates of 20, 30 or 40 g/m adjacent to a line of plants. It is used either upon emergence for a basal application, or later for top dressing. It is manually propelled and rates of 5 hours/ha are achievable. This equipment was developed by the International Institute for Tropical Agriculture in Ibadan, Nigeria as part of the no-till cropping system research programme. Using this equipment the time taken to fertilize a hectare of maize was reduced by over 60% in trials conducted in Nigeria.

The applicator uses a spiral agitator to meter the fertilizer to the discharge spout which delivers the fertilizer in a 2.5 cm band. The applicator weighs 16 kg.

MAHINDRA ENTERPRISES
507 Prince of Wales Avenue
Colombo 14
SRI LANKA



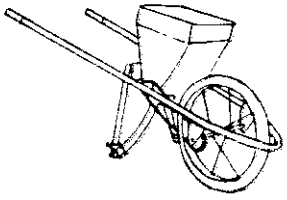
MASTER FERTILIZER SPREADER

This spreader is designed for use in small areas and is suitable for all kinds of fertilizer. It can be supplied either as a single-row unit, or, with an additional fitting, as a double row unit. Both can be operated by one person.

The spreader is operated by being pushed by hand and features a direct drive mechanism from the land wheel to the fertilizer metering wheel. The metering wheel is available in 3 sizes (22 mm, 18 mm and 14 mm), there being 2 wheels of each size. All wheels are interchangeable and can be used in any combination.

The spreader is made of mild steel and has a weight (empty) of 9.5 kg. The hopper has a capacity (granular fertilizer) of 12 kg.

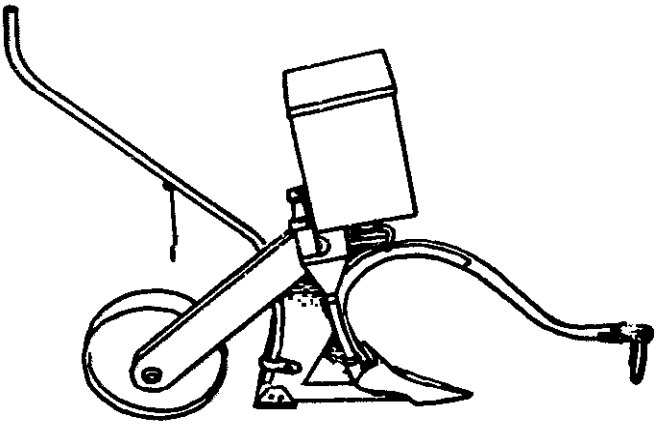
L.P. ENGINEERING CO.
Galloway Road,
Bishop's Stortford, Herts.
U.K.



FERTILIZER SPREADER

This barrow-type spreader is chain-driven from the land wheel. It can be supplied with two lateral placement tubes (shown here) or with two lateral and one central tube. Capacity 30 kg.

BIANCHI S.r.l.
26034 Piadena, Via Matteotti 60,
Cremona
ITALY

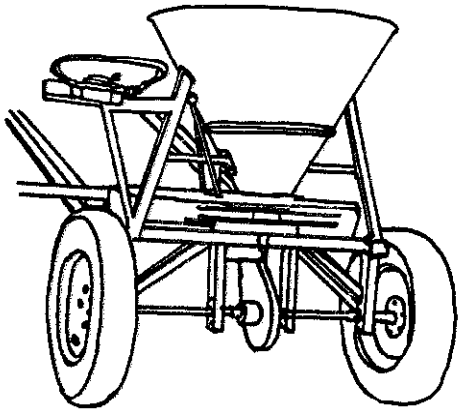


SEED AND FERTILIZER APPLICATOR

Designed to be drawn by a single animal, this seed and fertilizer applicator can be used for planting corn, sorghum, mung bean, soybean and upland rice. In a single operation it makes a furrow, applies the fertilizer and seed, and covers with soil.

Rates of application and spacing of seed and fertilizer are determined by interchangeable metering rollers. The fertilizer depth can also be controlled, as can the soil covering given to the seeds.

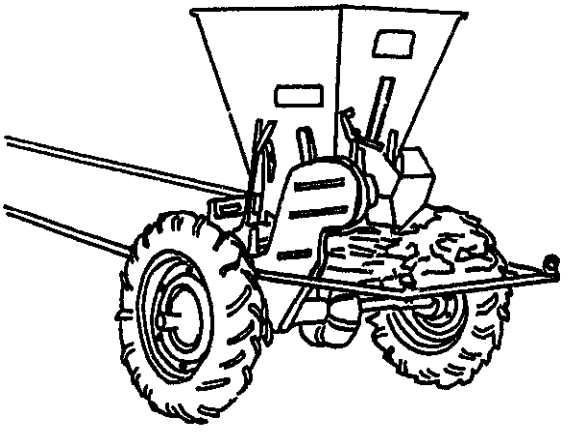
F. BUENACOSA REPAIR SHOP
Tacurong, Sultan Kudarat
PHILIPPINES



FERTILIZER SPREADER LS4

Designed to be pulled by any draught horse, the LS4 spreader can also be used by other animals such as mules and oxen. A strong box section steel chassis carries a rot-proof polythene hopper of 5 cwt capacity above an adjustable shutter operated by a lever beside the driver. Regulated by a simple pin and vernier system, the shutter aperture is variable to give different flow rates on to the spinner plate revolving below. Driven by a vee belt from a right-angle gearbox, the spinner is coupled by a chain and sprocket to the differential gear on the main axle. Both the gearbox and the differential box have sealed lubrication systems and require no maintenance. A feature of the LS4 is the incorporation of the differential which delivers a constant flow and therefore an even spread on any radius of corner while the hand lever gives instant cut-off on the headlands to avoid overspread.

THE CARTHORSE CO. LTD.
Egremont Farm, Payhembury
Honiton, Devon EX14 0JA
U.K.

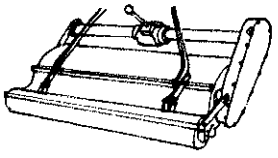


N-015 FERTILIZER DISTRIBUTOR

The N-015 horse-drawn fertilizer spreader is designed for broadcasting mineral fertilizers, granulated or powdered, as well as lime. The quantity of fertilizer to be applied per unit area can be adjusted by means of a slide damper at the rear of the 200-litre hopper, and relocation of the spreader disc.

The spreader disc is fed from the hopper via a belt conveyor which is tensioned on two rollers. The rollers are driven by the main wheels through a chain reduction gear and transmission which can be engaged or disengaged independently. The spreading disc is located on a sliding plate enabling adjustment of spreading range and direction. Actual range is 5.7 m for granular fertilizers and 3.5-5 m for powdered fertilizers.

AGROMET MOTOIMPORT
Foreign Trade Enterprise
P.O. Box 990, Warsaw
POLAND

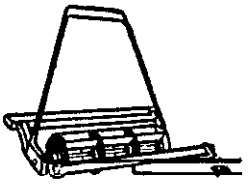


SEED COVERING MACHINE

This can be used for soil pulverizing and seed covering of broadcasted crops like wheat, legumes, green fertilizer, etc. It can also be used for fine soil pulverization after harrowing. It may be animal-drawn or powered by a small 2-wheeled tractor, and can cover about 0.3 ha per hour.

Manufactured by: DANYANG SEED COVERING MACHINE FACTORY, from

CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing, CHINA



GREEN MANURE TRAMPLER

This implement consists of 4×210 mm diameter steel discs with cast-iron hubs mounted in a horizontal pipe shaft. The horizontal blades mounted on the shaft cut the foliage and a cultivator or plough is needed after this operation for complete burial of the manure.

COSSUL & CO. PVT. LTD.
123/367 — Industrial Area
Fazalganj, Kanpur, UP
INDIA

5. CROP PROTECTION AND OPERATOR SAFETY

JOHN LOFTUS/ARSAP

Crops are subjected to attack by a wide range of pests that include insects, weeds and fungi. Unless these pests are effectively controlled at the right time, the quantity, quality and ease of harvest can be seriously reduced. Much research and experience has shown that the most effective means of achieving pest control is with the correct use of special chemicals called pesticides.

Pesticides are applied to a range of target surfaces that include the soil, crops, weeds and insects. Furthermore, the mode of action of these products is equally diverse. Some are very mobile or systemic — with areas of activity away from the point of deposition. In contrast, some pesticides only have an effect on that area which they contact. The longevity of a pesticide effect can also vary; some soil-acting residual herbicides will be effective for months whereas a pyrethroid insecticide may be active for a few hours only. However, pesticides have to be applied not only at the right time in the development of the pest or crop, but at the prescribed dose and in an approved manner, taking the appropriate safety precautions.

This section is mainly concerned with the means of applying pesticides using equipment available for smallholder farming. The task is eased by the almost universally common features such equipment embodies in its design — variations between makes and models often being one of size or refinement. However, alternative equipment is now available that uses different principles and reference is made to this as well.

Most pesticides are applied, dissolved or suspended in a liquid. The dilution rate used depends on the chemical, pest, crop and equipment. Briefly, it is possible to classify the mode of application by the volume applied per hectare:

High volume: around 200 litres/ha.

Very low-low volume: 10-50 litres/ha.

Ultra low volume: less than 10 litres/ha.

Similar equipment can apply the liquid in either high or low volume modes, but equipment for applying chemicals at ultra low volumes is significantly different.

Some pesticides are applied in a powder or granular form. An advantage of this is that they can be applied without specialist equipment e.g. the treatment of stored grain using malathion powder can be achieved without using any specialist equipment.

A few chemicals are applied as a gas e.g. phosphene in sealed grain stores.

Certain pesticides can also be used to control ectoparasites in livestock.

For each mode of application and each type of chemical, specific safety precautions must be taken, although there are general rules about personal hygiene, handling chemicals and what to do in the case of suspected poisoning. General guidelines are given below but the specific precautions, as recommended by the manufacturer and written on the chemical container, must be strictly adhered to.

TECHNICAL CHARACTERISTICS

Knapsack and Pressure cylinder sprayers

In these sprayers a diluted spray solution held in a convenient tank is forced through a small hole called a nozzle to produce drops that can be directed onto the treatment area. Spray tanks are available in a wide range of sizes but with a maximum limit of about 25 litres (quantities in excess of this amount cannot be easily carried). Tanks are usually slung knapsack fashion on the back but can be hand-carried too. A lever, which comes forward past the side of the body, is pumped up and down by one hand while the other directs the spray-forming nozzle fitted at the distal end of a semi-rigid lance. A small pressure control vessel is incorporated into the pump to smooth out pulsations and reduce the frequency of lever operations. In some models hand-pumping at the time of spraying is eliminated through the use of pressurized metal tanks. Spray liquid is put into the tank and then air pumped in manually, or from another cylinder, or from a compressed air line. Sometimes the spray liquid is forced into the tank compressing the remaining air. A convenient on/off tap between the pump and nozzle allows spray to be emitted only when needed.

The nozzle performs three main functions that can determine the success of the pesticide.

- The small hole restricts and thereby partially controls the flow of pressurized spray liquid.
- The issuing spray forms a sheet which disintegrates into drops that can be directed and distributed over a swath.
- The size spectra of drops is controlled by the size and design of the nozzle. To meet the varied needs of pesticides, nozzles are available in three main types — namely fan, flood or hollow cone — and a wide range of sizes.

The variety of nozzles available produce different flow rates for a similar pressure, different spray widths, different droplet sizes and ranges of droplet size. *Hollow Cone nozzles*, which give a fine mist hollow cone spray pattern; *Fan Spray nozzles*, which give a flat angle fan shaped spray pattern; and the *Floodjet* (e.g. Polijet) range of herbicide application nozzles which can provide a large droplet spray swath from a large orifice. The range of output spray volume rates can vary from 20 to 1000 litres/ha depending on the nozzle, the pressure and the walking speed of the operator.

On page 78 the table of Knapsack and Pressure Cylinder Sprayers lists a selection of 55 manufacturers from 18 countries. Readers are also referred to the recent International Plant Protection Center publication on Lever-Operated Knapsack Sprayers, in which data on 37 sprayers from 24 manufacturers in 15 countries is presented. Each is analysed in terms of its operational and safety characteristics, ergonomics and its design and construction.

Other hand-operated sprayers

A table on page 79 lists some of the many manufacturers who produce other types of hand operated sprayer. Seven types are itemized:

- *Trigger-operated sprayers* Operation of the trigger ejects a small spray or stream of liquid — the nozzle being usually variable. Capacity 0.25-2 litres.
- *Piston-operated sprayers* Liquid is sucked into the cylinder by withdrawing the piston/plunger then it is sprayed out by pressing the plunger home.
- *Hand compression sprayers* The container is put under pressure by pumping the handle on top. The liquid is then released as a spray by operating a trigger. Capacity 0.5-1 litre (occasionally more).
- *Hand atomizers* Air, forced out of a small orifice at the end of the piston, sucks up and atomizes liquid from the container which has a capacity of about 150 ml upwards.
- *Slide action sprayers* A back-and-forth pumping action on the hand grip produces a continuous spray.
- *Hand lever sprayers* The pump is operated by a lever. Usually used to spray chemicals from a bucket.
- *Stirrup pump* The pump is placed in a bucket and the plunger pumped up and down.

Motorized knapsack mistblowers

A third category of sprayers are powered by small engines. These are universally available and can be used for atomizing liquids and blowing the particles for considerable distances. Using a different hopper, dusts can also be blown by these machines. A third table lists a selection of manufacturers and details the specifications of their equipment (see page 80)

In the pages at the end of this section there is described a range of equipment for dusting, spreading granules and spraying. Equipment for dressing seed is mentioned as are a miscellany of devices for controlling other pests in crops.

Novel types of pesticide application equipment

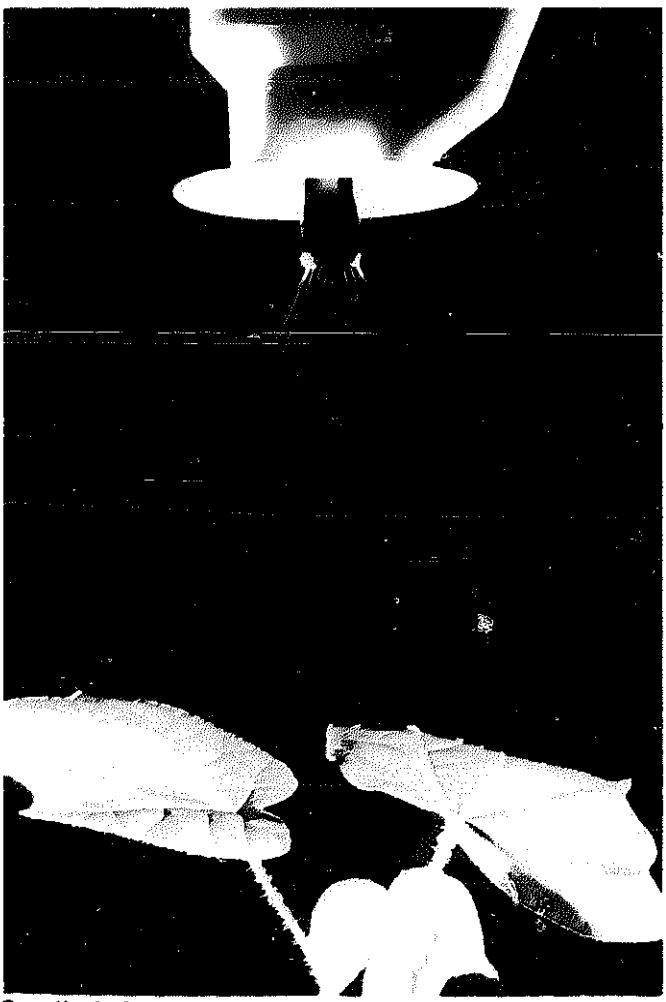
Of the many novel types of equipment, which include the rotary atomization controlled droplet application (CDA) sprayers which now find widespread use, two others are also itemized in this introduction for different reasons. The Electrodyn is mentioned because its design

represents a significant advance in pesticide application technology, and the weed wiper is mentioned because of the great potential this has for introducing herbicide technology to poorer farmers.

Rotary atomizers These produce drops directly or liquid ligaments (which then collapse into drops) from the edge of a rotating dish, disc or cage. The range of drop sizes produced is much less than that from conventional nozzles. The size of drop is mainly dependent on the speed of the disc's peripheral edge — higher speeds being used to produce small drops and low speeds large drops. Often small drops are purposefully produced and emitted into air-streams that are naturally or artificially induced to spread the spray over a very wide swath or penetrate dense leaf canopies. In contrast large drops readily free-fall and a predetermined swath can be applied. The system is always associated with the use of low spray volumes. The reliable use of reduced doses of pesticide has only been clearly demonstrated with very few products. Their advantages stem from the use of low volumes which demand less dilution and thereby permit greater ease and better timing. Less water for spraying is needed and the equipment is often lighter and easier to use.

The 'Electrodyn' Sprayer The 'Electrodyn' hand-held spraying system comprises a spray stick and 'Bozzle' container, a unique combination of bottle and nozzle.

Pesticide formulations for use with the spray stick come pre-packed, ready to use in a 'Bozzle' container. The integral electrically-conductive nozzle supplied with each 'Bozzle' is pre-set for the chemical and requires no calibration. It is always new and will provide the correct droplet size to optimize biological control. The electrodynamic atomization technique uses only 0.5-1.0 litres per hectare of the special oil-based formulations required to achieve good pest control. Thus, a single 750 ml 'Bozzle' container can treat up to 1½ crop hectares. The spray stick contains batteries and a solid-state high voltage generator which takes the 6V low voltage input from the four U-2 batteries and converts this to an output at the HV stud of 25 kV and a zero potential at the earth field electrode.



Detail of electrodyne bozzle in action.

Hectaspan rope-wick weedwiper.

Liquid is first formed into a number of evenly spaced ligaments, which in turn break up into uniformly-sized charged droplets. Droplet size and charge can be varied by manipulating the applied voltage. (Typically, 50-75 micron-sized droplets have been shown to be optimal for insecticides and fungicides. 100 micron droplets are preferred for herbicides.)

The droplets, which are mutually repellent and of even size, deposit a uniform coat on the crop. The charged droplets 'wrap around' the crop target so that underside coverage of leaves and stems is achieved. Charged droplets are attracted to the nearest earthed target. Little spray is deposited on the ground.

Weed wipers Weed wipers offer farmers the opportunity to place herbicides directly onto the target plant. Their main use has been with the systemic herbicide glyphosate. Weeds growing in crops can be safely treated using a non-selected herbicide. They can be used in confined areas or adapted for large-scale farming enterprises and possess few of the problems met in normal herbicide use. Their use is restricted to where the target surface is visually obvious and readily reached, and where there is a differential height between the weed and the crop. Direct wiping of weeds has been practised for some time, even before the advent of systemic herbicides. However, the invention of rope-wick wipers and a variety of other devices for transferring

herbicide to selected plant leaves has opened up possibilities for the introduction of herbicide technology to poorer farmers. This is particularly valuable for the control of perennial problem weeds. Their main advantages are their usefulness for applying non-selective herbicide to particular weeds above or between crop rows; the cheapness of the equipment compared to other devices, including knapsack sprayers; and the possibility of local manufacture.

Alternatives

Systems of Integrated Pest Management (IPM) are being developed and evaluated. In situations where pesticides have got to be used on a wide scale the possibilities of controlling pests by maintaining a healthy population of pest predator and intercropping of species (companion planting particularly) will avoid much of the damage caused by the build-up of pests and diseases which are resistant to commonly used chemicals.

In weed control, herbicides are not commonly used by poorer farmers but other forms of weed control and sanitation if used systematically will prevent the build-up of weeds. For example, the prevention of production or introduction of weed seeds can be built into a system through controlling the quality of crop seed, avoiding the introduction of weed seeds by other routes (e.g. the use of weed seed traps in irrigation systems); by having a vigorous crop stand which suppresses weed growth; by rotating crops; and by timely conventional weeding.

Costs and benefits

In crop protection, perhaps more than in any other part of the crop production system, the costs and benefits are clearly defined both in micro- and macro-economic terms. In micro-economic terms the cost of the input, which is often very high in developing (importing) countries, can be weighed against the yield advantage of crops which may have a relatively low price. The high cost of the input and lack of credit facilities often make it impossible for poor farmers to use chemical technology.

The cost of using powerful biocides can be high in human terms as well if adequate precautions (which can be costly in themselves) are not taken.

In macro-economic terms the cost of the input is often measured in its foreign exchange value. Pesticides, being often imported, can have a high opportunity cost of foreign exchange and hence be susceptible to shortages if there is a need to divert foreign exchange to other more needy purposes. For that reason, the cost of becoming committed to chemical technology can be high. If there is a shortfall of inputs for any reason, the effect of this on crop production could be considerable. Governments may also need to assess the environmental impact of introducing widespread use of pesticides.

Returning to the micro level approach it is perhaps useful to familiarize the reader with the economic technique of partial budget analysis. (Ref: R.K. Perrin et al, *From agronomic data to farmer recommendation: an economics training manual.*)

The concept of partial budgeting is that one only considers those costs which are affected by the particular decision being made. These costs are called *variable costs*. Thus, when considering the variable costs in the case of herbicides, one would examine the costs of the chemical and the labour costs of application, and the labour costs of hand-weeding under the different systems. Cost of planting, and of the seed itself, however, would not be examined as they are constant.

Costs would be measured in terms of market price for such inputs as the herbicide itself and in terms of opportunity cost when the input has no monetary value. Family labour, for example, would be costed in terms of the opportunity cost, which might be wage employment, other productive activities around the farm, or the value placed on leisure by the workers.

Yields would be quantified in terms of output per hectare and priced at market price, less the costs of harvest, storage, transportation and marketing of the increased output which is to be sold, or at the opportunity price of that which is to be consumed by the farmer. The opportunity price of the grain would be the price the farmer would have to pay for that grain on the market. This price is called the *Field Price*. *Yield* multiplied by *Field Price* gives the *Gross Field Benefit*.

The budgets for each option would then be drawn up on a per hectare basis, when *Variable Costs* would be subtracted from *Gross Field Benefit* to give a *Net Benefit* (See table below).

It must be emphasized, however, that this analysis takes no account of risk and uncertainty and the availability of credit. Thus the most attractive option may not be feasible or desirable in practice.

The same technique of economic analysis can be used to assess the advantage of using improved pesticide application equipment where the main benefits might be saving of time in application and reduced application rates.

Just one final note on the costs of pesticide application. As said earlier the majority of pesticide is applied in a liquid, usually water, and the availability of clean water in the field is therefore essential. This can be a very costly input in terms of the time needed to bring the water to the field.

Example of a per hectare partial budget.

	Present practice	Use of herbicides
Benefits		
farmer's yield (net yield)	2.0 tons	2.5 tons
farmer's value (field price)	$1000	$1000
total benefit (gross field benefit)	$2000	$2500
Variable costs		
herbicide:		
amount	—	2 litres
value (money field price)	—	×$30
total (field cost of herbicide)	—	$60
labour for application:		
amount	—	2 days
value (opportunity field price)	—	×$10
total (field cost of application labour)	—	$20
labour for hand weeding:		
amount	10 days	3 days
value (opportunity field price)	×$10	×$10
total (field cost of weeding labour)	$100	$30
total variable costs	$100	$110
Net benefit	$1900	$2390

Note: the $ symbol in this manual represents no particular national currency. Weights are in metric units.

Special considerations

Maintenance The holes in the nozzle are eroded in use and can corrode when stored. It is imperative that the liquid throughput of the nozzles is regularly and thorougly checked. Failure to do so may result in more pesticide being applied than is necessary and worse still, with herbicides, could damage crops. Regularly check the throughput of the nozzle and calibrate. Visually examine the distribution of the spray too. Spray on to a dry surface and see how uniformly the liquid dries. Is the breakup of the liquid sheet from the nozzle uniform or are there thick ligaments or partial blockages? Clean and replace the nozzles as necessary.

Seals will sometimes leak — often not because they are worn but because of dirt. Rinse in clean water and refit before using too much force.

The spray tank and pipes can split and leak. It is essential that they are rectified or, better, replaced. The on/off trigger must work quickly and completely. Some have devices to lock the trigger open or off. Make sure they work.

Before using any sprayer in the field visually check that the pipes and their clips, the tank, harness or carrying straps are in good order and securely fixed. Use clean water and try the sprayer out. Make sure it is working properly and the harness is comfortable. Make sure the operators are trained in its efficient use. The penalty for insufficient training can show in poor pest control, crop damage, and possibly ill-health for the operator.

Health and Safety The text from here to the end of the chapter is reproduced in full from *Pesticides, a Safety Guide 1982* prepared by Shell International Chemical Company Ltd., Agrochemical Division, Shell Centre, London, SE1 7PG, U.K., by kind permission of the Public Affairs Division. The problems of misuse of pesticides are so serious that the author would encourage all those who purchase agrochemicals to read the following pages with care. At the end of this extract there is a table of safety equipment manufacturers who can advise on and provide relevant safety equipment. Similar advice has been provided by other major agrochemical manufacturers who can provide details on request.

Personal hygiene

Measures to be taken to ensure personal hygiene by anyone who handles or comes into contact with chemicals are largely a matter of common sense. Chemicals can enter the body by three routes; through the mouth (ingestion/swallowing), through the skin (dermal exposure) or through inhalation, e.g. of vapours, small particles of dust or droplets of liquid. Of these three routes, dermal exposure represents the most frequent hazard to those who handle pesticides. Inhalation is important with volatile products, airborne dusts and with formulations based on volatile solvents which can themselves present a hazard. Personal hygiene involves avoiding exposure by taking appropriate precautions, using protective clothing and equipment and thoroughly washing all exposed parts of the body after work and before eating, drinking, smoking or using the toilet.

If a container has leaked and the surfaces of other containers are contaminated this may appear as staining, or as a powdery deposit, or it may have affected the label. When any of these signs are seen, or where the more hazardous products are being handled, care must be taken to prevent skin contamination.

The degree of hazard from the many different pesticidal products varies very widely. Even with products containing the same active ingredients there may be great differences in the risks to employees, e.g. dusts containing low percentages of toxicant may be relatively harmless while liquid formulations may produce significant hazards when in contact with the skin or if inhaled. It is therefore important that all personnel handling pesticides should read, or be told about, the potential hazards of the different products they are handling. When an unfamiliar product is received the essential information on the precautions to be followed will be given on the product label, therefore it is as important for the handlers, as for the users, to READ THE LABEL.

When leaking containers are found, or spillages occur, the personal hygiene recommendations given in the relevant product sheet must be followed. However, the following general recommendations always apply:

At least two people wearing protective clothing should be present when a spillage of a more hazardous product is being dealt with, or when a leaking container is being decanted into a clean empty drum.

All persons dealing with any incident should wash hands and exposed skin thoroughly with soap and water as soon as possible and before eating, drinking, smoking and using the toilet. On completion of work wash thoroughly, or if available take a shower. If powders are involved the hair should also be washed.

Protective clothing/gloves/boots/head coverings/aprons, etc. as well as overalls need to be thoroughly washed after use.

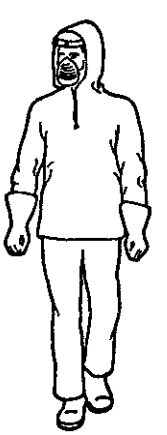
All items of protective clothing, equipment, etc. should be checked at regular intervals to ensure that they are in good condition and ready for immediate use. These essential items should be kept in, or close to, the pesticide store in a specially marked locker.

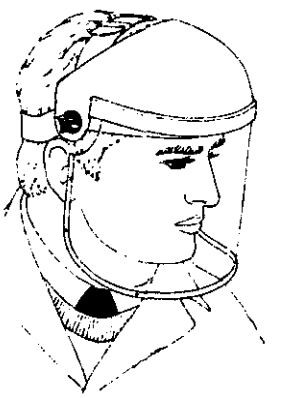
Protective clothing

All personnel who are working with pesticides, e.g. in stores, formulation plants, etc., should wear at least some protective clothing. In hot climates, there usually has to be a compromise between desirable protection and comfort, but as a minimum precaution all workers should wear an overall. This recommendation has the following advantages:

a. There is no risk of normal clothing being contaminated.
b. Overalls can be washed (or discarded if of disposable type) regularly and after any contamination.

Protective clothing for ULV mistblower operator.





face shield

c. People will work more efficiently if they do not feel that their own clothes may be damaged or contaminated when handling pesticide containers.

Overalls should be worn by *all workers*. In addition, those handling containers, carrying out transfer operations, cleaning up spills, etc. must wear protective gloves and rubber boots. There should be no compromise over these basic levels of protection.

Overalls These should be of cotton, 'boiler-suit' type fastening at the wrists and neck. White overalls have the advantage of showing up contamination. Some suppliers now offer light-weight types specially for hot climates as well as disposable or short life types. (Of note is Tyvek clothing, available from Bigneat Ltd. U.K. — Ed.)

Head coverings When powders or dusts are frequently handled, the wearing of an easily washed cotton cap is to be recommended.

Boots These will need to be worn when cases of leakage or accidental spillage of more hazardous materials occur. They should be without laces and of any impervious material (e.g. rubber). The overalls should be worn outside and not tucked into the boot tops. They should be regularly inspected for damage and possible leaking. In hot climates, a supply of cotton socks will make boots more acceptable.

Protective aprons Ideally these should be of neoprene rubber. They should reach from the top of the chest to below the tops of the boots and wrap around to cover the sides of the legs.

Face shields and goggles These are worn to give protection to the eyes against possible splashes, etc. Face shields have the advantage of being cooler in hot climates and do not 'mist-up' as easily as goggles but they offer less protection against irritant vapours and spray mists.

Decontamination of protective clothing After use, all items should be thoroughly washed with soap or detergent and water, and well rinsed.

Protective gloves

These are the most important items of safety equipment required in any pesticide store. They should be worn whenever there is a risk of skin contamination.

The type of glove is important and a sufficient number should be available to meet any emergency. They should always be of the gauntlet type (worn under the overall sleeve) and not short gloves ending at the wrist.

Very thick gloves may be too heavy and inflexible for efficient handling, while very thin gloves may be too easily damaged to be economic. Gloves incorporating a cloth lining are undesirable since the plastic or rubber coating may be damaged and allow the cloth to become impregnated with the pesticide.

Types of protective gloves There is little difference between nitrile rubber, PVC or neoprene gloves, though neoprene is usually preferred. PVC gloves are resistant to abrasion, but tend to crack with age. Nitrile rubber gloves are often less expensive than neoprene, but they have a tendency to harden and crack. Polyethylene gloves show good resistance to pesticides, but often have a tendency to tear. Natural rubber gloves are not recommended as they have poor resistance to many solvents used in liquid formulations.

Aromatic and halogenated hydrocarbons will attack all types of natural and synthetic gloves. If swelling occurs, change to another pair, allowing the swollen gloves to dry and return to normal. If organophosphorus pesticides have been handled, follow the instructions below before reusing them.

Cleaning gloves after use Immediately after use gloves should be well washed with soap or detergent and water BEFORE being removed from the hands. After removal they should be turned inside out and again be thoroughly washed, rinsed, rubbed dry and allowed to dry completely in a well ventilated place before being stored again in the locker for safety equipment.

If organophosphorus pesticides have been handled, gloves should be soaked in alkali solution for at least eight hours, rinsed and dried before re-use.

Note: Long and frequent contact with organophosphorus pesticides can result in the rubber becoming impregnated with the pesticide. When there is a risk that this has happened the gloves should be destroyed.

Testing for leaks During the rinsing stage the gloves should be held at the top under water and firmly squeezed to check that no leaks have developed. If a leak is seen they should be discarded.

Low pressure inflation with air is also useful for testing for leaks. The inflated glove is held under water and checked for the absence of air bubbles.

Respiratory protective equipment

Wherever vapours or dusts from pesticides and solvents disperse in the working area, there is an inhalation hazard.

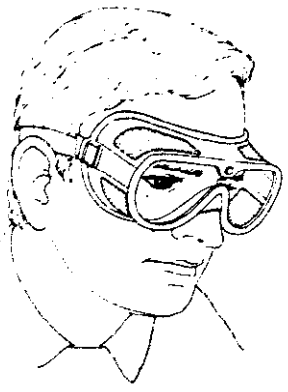
Ingredient discharge and product filling lines of established formulation plants should be protected by exhaust ventilation hoods connected to the ducting of efficient industrial ventilation systems with fans to prevent dispersion of the harmful products into the working area.

A ventilation system is the preferred protection against inhalation hazards because respiratory protective equipment (as worn by the operator) has the following disadvantages:

— Inconvenient to wear, especially in tropical climates and therefore abused;
— Limited life of cartridges or canisters and therefore expensive if replaced as necessary for effective protection.

However, there are situations like leaking containers in warehouses, spillage clean-up, plant maintenance, etc. in

full face mask



goggles

which use of respiratory protective equipment is necessary.

The various types of equipment are illustrated as follows:

Simple dust mask These are of paper, synthetic material, gauze (surgical mask) or cellulose. They give protection to the nose and mouth against particular matter (dust). They are not suitable for protection against vapours but have been found to give a degree of protection against liquid sprays and aerosols.

Half face mask This covers the nose and mouth only and has a cartridge filter attached. Since no protection to the eyes is afforded, a half face mask should always be worn with goggles or face shield. Half face masks give protection against dusts and/or vapours depending on the cartridge selected.

Full face mask Also known as chemical cartridge or canister respirator, this device covers eyes, nose and mouth and may have the cartridge attached or be connected by a flexible tube to a canister carried on a belt round the waist. The part covering the eyes can be a one piece shield or separate eye piece giving the appearance of goggles.

This equipment is the most commonly encountered under the heading of 'respirator'. Protection against dust and vapours depends upon the cartridge selected.

Fresh air breathing apparatus This consists of a full face mask with a flexible air line to draw air from outside. Alternatively air can be supplied from a compressor or the equipment attached to the compressed air line of the plant or installation where it is used. Only clean air suitable for this type of apparatus can be used.

Self-contained breathing apparatus This is heavy and cumbersome equipment in which cylinders of air are carried on the back of the wearer. It is normally used only by Fire Service personnel or other professional operators.

In or near all stores where the more poisonous pesticides are held, there should be at least two serviceable respirators in their individual containers within a specially marked locker.

Those employees likely to be required to deal with spillages, leakages, etc., of more poisonous products, should be instructed in the wearing of respiratory protective equipment, so that it will be worn and used properly when the need arises.

Note: If a man is bearded, it is frequently very difficult to fit the respiratory protective equipment to give an air-tight seal. With a half face mask a similar problem may arise with large moustaches!

Replacing cartridges or canisters Many makers recommend that cartridges should be replaced after a total of about 30 minutes to 8 hours use in the presence of the pesticide. The maker's specific recommendations on this matter should ALWAYS be followed. Irrespective of the length of use of the cartridge or canister, it should be changed immediately if the wearer of the respirator can detect any slight smell of the pesticide. It should be noted that in the presence of a lot of dust the filters may become clogged and so make breathing difficult. If this occurs the whole cartridge should be changed.

In tropical countries high humidity and temperature may shorten the stated service life of the cartridge or canister.

Use of respiratory protective equipment The situations which require respiratory protective equipment to be worn are given in data sheets [available from Shell].

simple dust mask

half face mask

When a respirator is being put on the head, the maker's instructions must be followed. It is essential that care is taken to see that it fits closely to the face so that it prevents any air entering except through the cartridge or canister. However, it should not fit so tightly that it causes excessive discomfort to the wearer. It must be recognized that the wearing of respirators is unpleasant, especially under tropical conditions and this can be partially overcome by giving rest periods out of the danger area.

Note 1: It may be highly dangerous for workers to wear respirators when the cartridges (or canisters) have exceeded their service life. If there is any doubt at all, new cartridges (or canisters) should be fitted.

Note 2: It is highly dangerous to rely on cartridge/canister respirators in enclosed spaces deficient in oxygen. Under such circumstances fresh air or self-contained breathing apparatus must be used.

After use Remove the cartridge (and filter if separate) and carefully wash the face-piece inside and out with soap and water and rinse well to remove all traces of soap.

Safety in use

Safety in use involves the precautions that need to be taken during handling of products and application in the field in order to safeguard the health of operators, bystanders and the general public and to protect the environment. Safety precautions are largely a matter of common sense, for example, avoiding exposure to spray, taking special care when preparing spray solutions, paying attention to personal hygiene (see Personal Hygiene section), avoiding spray drift. In some instances, however, depending on the nature of the product involved and the job being done, special precautions are required. These may need the use of certain items of protective clothing or equipment and full details will appear on product labels.

Development of safety precautions The starting point is consideration of the acute toxicity of the product. However, toxicity is the *ability* to produce a harmful effect. In developing safety precautions one is concerned with hazard which is the *probability* that a harmful effect will occur in practice. Safety is the inverse of hazard, that is, the degree of freedom from hazard or risk. It must be remembered that all activities carry some risk and

absolute safety is therefore unattainable. To reduce risks to acceptable levels is the objective of precautions.

Probability, in the context of hazard, is related to degree of exposure to the material in question; thus hazard is a function of two factors, toxicity and exposure. Expressed mathematically, this becomes:

Hazard $\propto$ Toxicity $\times$ Exposure

So if exposure is zero (impossible to attain) there is no hazard. Similarly if toxicity is zero (again not possible, even water has toxic properties), hazard vanishes. The important point here is that degree of exposure is related to conditions of use which are therefore equally as important as toxicity so far as hazard is concerned. The quantitative application of the above relationship is made difficult because whereas toxicity can be measured in the laboratory and assigned a value, determination of exposure is much more difficult. Usually, a subjective assessment of exposure has to suffice, but quantitative data can be obtained by monitoring the exposure of operators under actual field conditions.

Which toxicity? As mentioned in the Personal Hygiene section, a pesticide can enter the body by three routes — through the mouth (oral) through the skin (dermal or percutaneous) and by inhalation. So far as hazards relating to the handling and application of pesticides are concerned, the highest probability of exposure is by skin absorption and it is therefore dermal toxicity that has most relevance in hazard assessment. Moreover, one should consider the dermal toxicity of the product (formulation) being handled and applied since the toxicity of an active ingredient can be mitigated by formulation, e.g. low concentration granules, solvents that do not assist skin penetration for Ultra Low Volume (ULV) formulations.

Handling formulated products Handling operations involving the concentrated formulations such as transferring from one container to another, filling spray tanks, preparing dilutions, clearing up spills are generally more hazardous than spraying in the field and precautions must be taken to avoid accidental splashing of concentrates on the skin or in the eyes. As a minimum precaution during handling, protective gloves should be worn and depending on the toxicity of the formulation, a face shield also.

Handling and applying solid formulations is usually less hazardous than liquids. Granules generally contain low concentrations of the pesticide and solid formulations are not based on solvents which can assist skin penetration of the active ingredient. Wettable powders on the other hand contain much higher concentrations of pesticide and moreover, consist of very fine particles. Care is therefore needed to avoid raising a dust cloud that may contaminate the operator and his surroundings during handling operations. Using a simple dust-mask is a sensible precaution while handling and mixing wettable powders.

Application in the field. Conventional water-diluted sprays: These sprays are applied very dilute and it is unlikely that absorption of significant amounts of active ingredient would occur under normal conditions. However, the advice in the product sheet as well as that on the label must be consulted. It is a wise, common sense precaution always to wear cotton overalls during application as a minimum precaution and to pay attention to personal hygiene. Operators should not eat, drink or smoke while spraying.

Treating crops with a canopy (e.g. top-fruit) or spraying overhead (e.g. hops) can result in the hazard of spray falling back onto the operator and in such cases waterproof clothing and a hood are usually required to minimize exposure.

Aerial application Aerial application involves hazards to loaders, flagmen, pilots, bystanders, neighbouring crops, waterways, etc. and special precautions need to be observed. In many countries regulations apply to aerial application and in others 'codes of practice' or other recommendations exist which, of course, should be strictly observed.

Ultra Low Volume application Application of ULV formulations needs special mention since these are applied without dilution and therefore the operator is potentially exposed to a more concentrated spray than with water-diluted sprays. This is an important consideration in relation to hand-held ULV application where operators are usually involved in both handling (bottle filling) and spraying. With hand-held ULV application, operators are in close physical proximity with the spray and special care has to be taken to minimize exposure by paying proper regard to wind speed and direction. Also with ULV sprays, droplet size is much smaller than higher volume sprays and this can present the additional hazard of inhalation.

After application Safety precautions do not end when application is finished. Equipment has to be cleaned and maintained and put away in good condition ready for the next time. Also, partly used containers must be reclosed and returned to store. Empty containers and surplus or waste products should be disposed of safely (see section on disposal) and not allowed to contaminate natural water.

Finally, operators should change out of working clothes and take a bath or shower.

Disposal of empty containers Empty pesticide containers should not be re-used except in special circumstances, e.g. for another formulation of the same active ingredient or where the container is regularly returned by the customer for re-filling. To prevent unauthorized re-use containers should be thoroughly emptied, washed-out and punctured or crushed.

Adequately decontaminated and punctured or crushed containers will generally be accepted by waste disposal contractors and local collection services. Approval should be obtained before depositing on public dumps.

In cases of poisoning

Basic principles Hazardous chemicals can be handled safely providing the correct precautions are taken. Poisoning nearly always happens as a result of negligence or misuse.

Firms and organizations which store or handle pesticides must be aware of the toxic hazards associated with the products in their care. Equally, they should be familiar with the first aid procedures appropriate for individual products, and have readily available the advice that will assist doctors and hospitals in providing the correct treatments.

It is advisable to know the name, address and telephone number of the nearest physicians and/or local hospital, so that contact can be made without delay, should a case of actual or suspected poisoning occur.

Prior arrangements should be made with a local physician, so that he can be contacted at once if a case

of poisoning occurs. He should be given basic medical information on the products handled, in order to give appropriate medical treatment. He should be asked to hold a stock of antidotes.

First aid procedures and medical treatment (advice for medically qualified personnel) are given in product sheets [available from Shell] The following general advice is applicable to all cases of over-exposure and to suspected or actual intoxication by pesticides.

If not known, try to find out which product was the cause of the poisoning and how it was absorbed, i.e. by mouth, through inhalation or through the skin.

First Aid procedures Carry out the FIRST AID PROCEDURE recommended for the product involved. While first aid is being administered, arrange for medical attention to be obtained urgently or take the patient to the nearest hospital.

If material has been spilled on the skin, immediately remove the patient from the source of the contamination, remove all contaminated clothing and wash affected areas with soap and running water. If material is in the eyes, flush with clean water for at least 15 minutes. Keep patient prone and quiet. Start artificial respiration immediately if patient is not breathing (taking care not to contaminate yourself).

If material has been swallowed DO NOT INDUCE VOMITING unless:

a. It is *specifically* advised to do so on the label or information data sheet.
b. The *material* (if a liquid) swallowed was one of the bipyridylium herbicides (paraquat, diquat).
c. The *material* swallowed is known to have an acute oral (rat) LD_{50} of less than 20 mg/kg.

If induction of vomiting is advised attempt it by stimulating the back of the subject's throat with a finger, but only if the patient is conscious.

Do not use salt water as an emetic.

NEVER GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON.

If the induction of vomiting is not called for, give activated charcoal (if available), but only if patient is conscious. Keep patient warm and at rest.

Medical advice When medical assistance arrives or at hospital advise the physician or those concerned of the 'in cases of poisoning' section of the relevant product sheet. Tell them how the accident occurred.

Bill Taylor
Hartvig Jensen,
Denmark

References

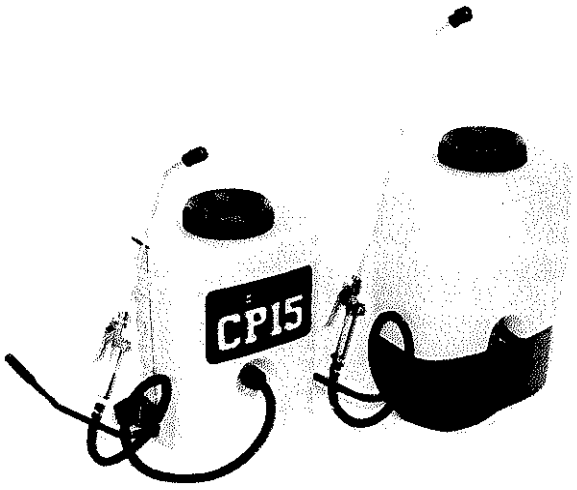
R.K. Perrin et al (1976) *From Agronomic Data to Farmer Recommendations: An Economics Training Manual* Information Bulletin 27 CIMMYT Apartado Postal 6-641 Mexico 6 D.F. Mexico.

H.H. Fisher & A.E. Deutsch (1985) *Lever-operated knapsack sprayers: A practical scrutiny and assessment of features, components and operation — Implications for purchasers, users and manufacturers.* IPPC, Oregon State University, Corvallis OR 97331 USA.

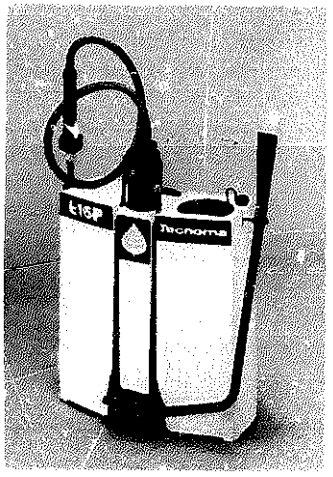
Anon (1982) *Pesticides, A Safety Guide* Shell International Chemical Company Ltd., Agrochemical Division, Shell Centre London SE1 7PG, UK.

Manufacturers and suppliers of safety equipment

Manufacturer	Country	Face Shield (against liquid splashes)	Goggles (against liquid splashes)	Safety Shield (power saw operators)	Spectacles (power saw operators)	Hard Hats	Waterproof Hats	Dust Masks	Single Respirator	Double Respirator	Full Face Respirator	Forced Vent. Full Face Respirator	Fresh Air Breathing App. No Air Supply.	Self Contained Breathing App	Waterproof Clothing	Neoprene Clothing	Tyrek Clothing	Gloves	Boots	Protected Boots
Martindale Protection	U.K.		●					●	●											●
Geiger International	U.S.A.	●	●		●	●	●	●	●	●	●		●	●	●	●		●	●	●
American Allsafe	U.S.A.	●	●	●	●	●	●	●	●	●										●
Bigneat Ltd.	U.K.																●			
Chapman & Smith	U.K.		●	●				●	●	●	●									●
Chubb Panorama	U.K.		●	●	●	●														●
Itex Safety	U.K.	●	●	●	●	●		●	●	●								●	●	●
3M	U.K.			●		●		●	●		●	●								●
Edward Macbean	U.K.														●					●
Mapa Beltex	France																	●		
Melco	U.S.A.						●								●					●
Monsoon	U.K.														●					●
MSA	U.K.				●		●		●	●	●		●							
G North	Zimbabwe	●						●	●	●										
Parmelee	U.K.	●	●	●	●			●	●											●
Plus 50	U.K.	●	●	●	●	●	●	●	●				●		●			●	●	●
Plysu	U.K.																	●		●
Protector Safety	U.K.	●	●	●	●	●	●	●	●	●			●	●						●
Pulmosan Safety Equipment	U.S.A.	●	●	●	●	●		●	●		●		●			●		●		●
Racal Airstream	U.S.A.											●	●							●
Racal Safety	U.S.A.	●	●	●		●		●					●	●						●
RFD Personnel Protection	U.K.			●		●										●				●
RMJ	U.K.		●			●									●			●		
Safety Products	U.K.	●	●	●	●															●
Siebe Garman	U.K.								●	●	●		●							●
Totectors	U.K.		●	●	●	●		●	●	●	●				●			●	●	●
John Ward	U.K.			●		●		●							●		●	●	●	●



Cooper Pegler Knapsack sprayers (cp15 cp3)



Tecnoma Knapsack Sprayer t16p

Mesto pressure cylinder sprayer 3590

Table of Knapsack and Pressure Cylinder Sprayers

Manufacturer	Country	Selection of Models Available: Knapsack sprayers	Cylinder sprayers	Plastic tanks	Metal tanks	Plastic pumps	Metal pumps	Range of tank capacities litres	Range of Empty Weights (where known) kg
AGROMET	Poland	●		●				12	5
ALLMAN	U.K.	●		●				16-20	
ARRIGUTTI CETTA	Argentina	●	●	●	●		●	12-20	
AMERICAN SPRING & PRESSING WORKS	India	●	●	●	●	●	●	9-16	4.3-8.2
ASE	Belgium	●		●	●		●	12-18	4.0-4.5
ASIAN AGRICO INDUSTRIES	India	●	●	●	●			6-16	
R. & F. BERTANI	Italy	●	●	●	●	●		6-15	
P. BERTHOUD	France	●	●	●	●			7-18	
B. & G. EQUIPMENT	U.S.A.	●	●	●	●	●	●	2.2-22	
BIRCHMEIER & CO.	Switzerland	●	●		●		●	5-20	1.85-6.7
BLIMA BARU	Indonesia	●			●			10	6.5
CARUELLE	France	●	●	●	●			6.5-20	2-5.3
CHINA NAT. AGRIC. MACHINERY IMP. & EXP. CORP.	China	●						16	5.5
COLINAGRO	Colombia	●	●		●			10-20	6.0-9.2
COOPER PEGLER	U.K.	●	●	●	●	●		10-20	3.6-5.4
EVERS & WALL	U.K.	●						15-20	5.0
GLORIA-WERKE	W. Germany	●	●	●	●			5-17	2.2-6.8
HATSUTA IND.	Japan	●	●	●	●			4-19.5	1.2-6.2
HOBRA MANUFACTURING	Kenya	●			●		●	16	
HOCKMAN-LEWIS	U.S.A.	●	●	●	●	●	●		2.6-8.3
HOLDER	W. Germany	●	●	●	●			5-18	1.8-5.8
HOMECO	Netherlands	●	●	●		●	●	6-18	
JACTO	Brazil	●	●	●			●	4-20	1.4-5.75
KIORITZ CORP.	Japan		●		●			4.4-8.8	1.2-3.2
KRUSHI VIKAS SADAN KENDRA	India	●	●		●	●		14-16	
KUMAON NURSERY	India	●	●	●	●			8-16	
K.W.H. WHIRLWIND	Netherlands	●	●	●	●			6-15	
LURMARK	U.K.	●		●				15-20	4.0
MAHARASHTRA AGRO. IND. DEV. CORP.	India	●		●	●			16	
MARUNAKA SPRAYER & DUSTER MFG. CO.	Japan	●	●		●		●	3-15	1.7-6.0
MESTO SPRITZENFABRIK	W. Germany	●	●	●	●	●	●	5-18	2-5.5
MORAVA	Yugoslavia	●	●		●			12-15	7.5-10.0
MURATORI	France		●		●		●	3-13	
MUSUHAMA	Indonesia	●			●			13-18	6.0-7.0
MUTOF	Indonesia	●			●			13	6.5
NITTO SEISAKUSHO CO.	Japan	●	●		●		●	3.8-17	
OAKES DEL PERU	Peru	●	●	●	●			15-20	5.1-6.15
PADGILWAR AGRO. IND.	India	●		●				16	7.5
PHYCO	Netherlands	●		●	●	●		10-20	3.8-6.6
CARL PLATZ	W. Germany	●	●	●	●		●	5-18	1.8-5.8
PRAPOULOS BROS.	Greece	●	●	●	●			9-16	
PURNHA SADHANA	Indonesia	●			●			10	5
R.C.M.	France	●	●	●	●		●	6-20	
ROOT-LOWELL CORP.	U.S.A.	●	●	●	●	●	●	13.2-20	3.6-4.5
SIGMA STEEL IND.	India	●	●		●		●	6-16	3-7.5
D.B. SMITH	U.S.A.	●	●	●	●	●		7.7-18.9	
SOLO SPRAYERS	U.K.	●	●	●	●	●	●	9.9-18	5.5
TECNOMA	France	●	●	●				5-20	
TIFA	U.S.A.		●		●		●	13.2	5.5
TROPIC	Cameroon	●							
VEGYEPSZER	Hungary	●		●				5-18	2-5.8
WEST BENGAL AGRO-INDUSTRIES CORP.	India	●	●	●				13-14	6.5
WILLCOX GROUP	U.K.	●	●		●		●	2-16	6.4
WHITE STAR PRODUCTS	New Zealand		●	●				5	
ZANA ZA KILIMO	Tanzania	●		●				14	
HARTVIG JENSEN	Denmark	●	●	●		●		7-20	1.5-5.0

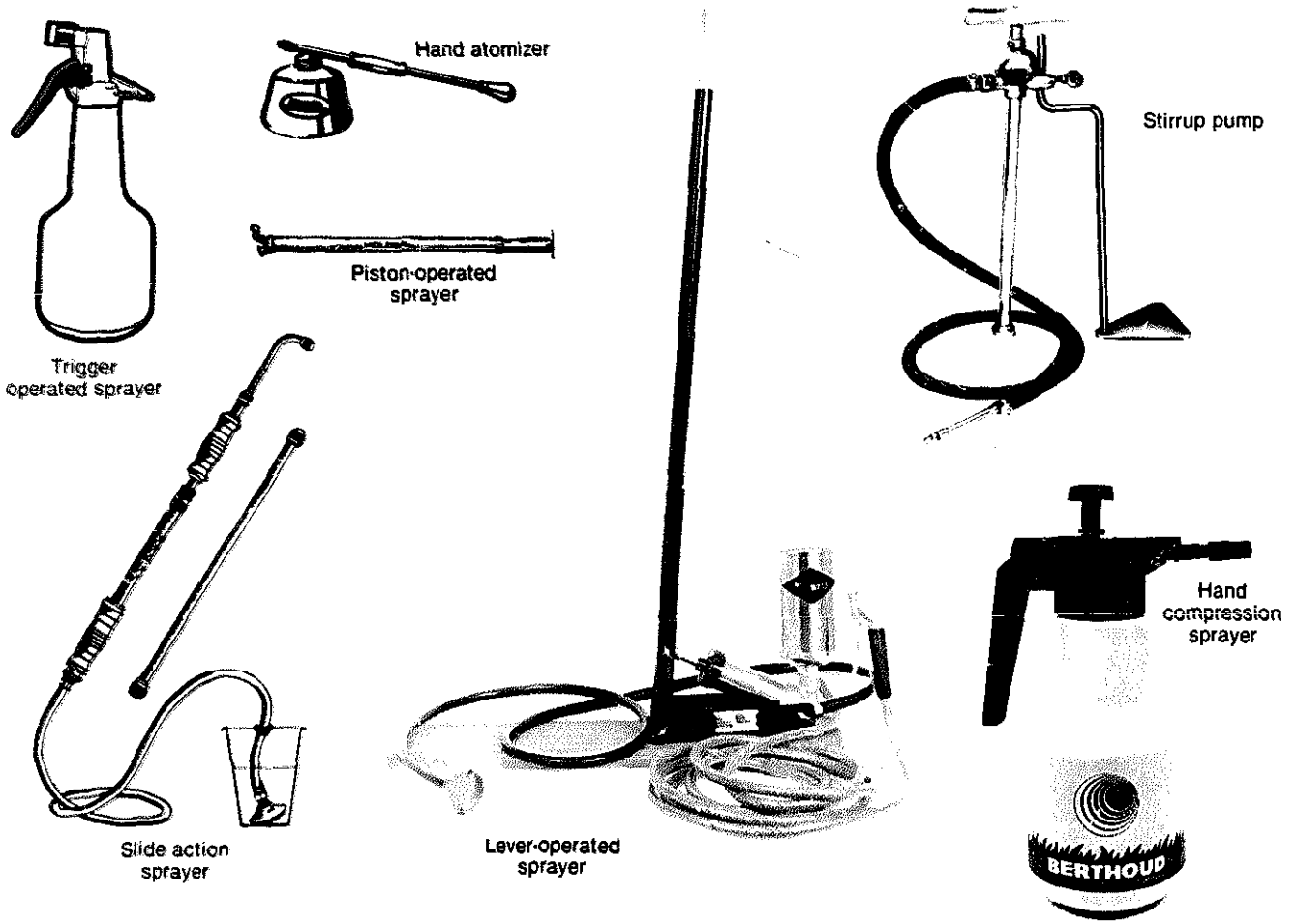
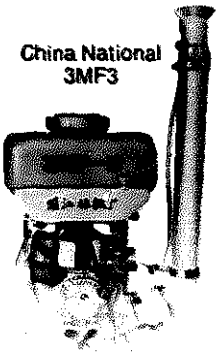


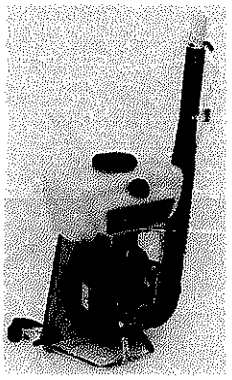
Table of other Hand-operated Sprayers

Manufacturers	Country	Trigger operated sprayer	Piston-operated sprayer	Hand compression sprayer	Hand atomizer	Slide action sprayer	Lever-operated sprayer	Stirrup pump
ARRIGUTTI CETTA	Argentina							●
AMERICAN SPRING + PRESSING WORKS	India			●	●	●	●	●
ASIAN AGRICO INDUSTRIES	India					●	●	●
ASL AIRFLOW	U.K.	●						
R & F BERTANI	Italy		●	●	●	●	●	●
COLINAGRO	Colombia				●	●		●
DUNWELL PRODUCTS	Zimbabwe							●
GLORIA-WERKE	W. Germany						●	
HATSUTA INDUSTRIAL	Japan			●		●	●	●
HOBRA MANUFACTURING	Kenya					●		
HOCKMAN-LEWIS	U.S.A				●			●
HOLDER	W. Germany	●	●		●	●	●	
HOMECO	Holland					●		
JACTO	Brazil			●				
KIORITZ CORP.	Japan				●			
KRUSHI VIKAS SADAN KENDRA	India			●		●	●	●
KUMAON NURSERY	India							
MARUNAKA SPRAYER & DUSTER MFG.	Japan	●		●	●	●		
JEAN MASSE	France					●		
MESTO SPRITZENFABRIK	W. Germany	●		●	●	●		●
MORAVA	Yugoslavia					●		
MURATORI	France	●						
NITTO SEISAKUSHO	Japan			●	●		●	●
CARL PLATZ	W. Germany	●				●	●	
ROOT-LOWELL	U.S.A.				●	●		
SIGMA STEEL IND.	India						●	●
SOLO SPRAYERS	U.K.		●			●		●
WEST BENGAL AGRO. INDUSTRIES	India			●		●		●
WHITE STAR PRODUCTS	New Zealand			●	●	●		

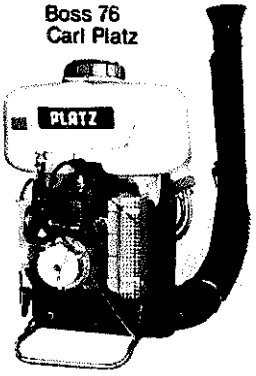


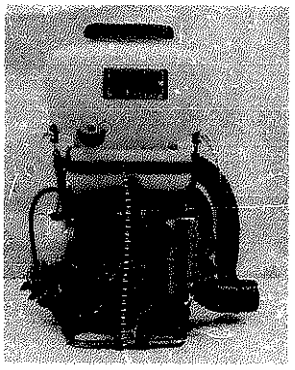
China National 3MF3

Cooper Pegler Hurricane Minor



Boss 76 Carl Platz

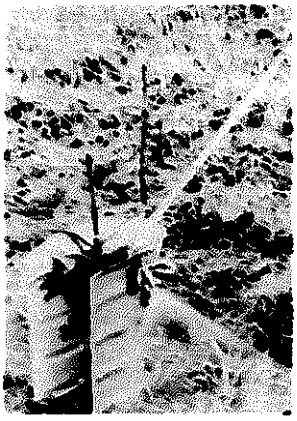




Blowmic AM 15II

Manufacturer	Country	Model	No of Models	Tank Capacity (litres)	Spraying: Discharge Rate (litres/min)	Dusting: Tank Capacity (kg)	Dusting: Discharge Rate (Kg/min)	Range: Horizontal (m)	Range: Vertical (m)	Engine Type	Power	Fuel Tank Vol (litres)	Weight (kg)
E. ALLMAN & CO.	U.K.	L80A	1	14	4					C7	5hp	2	12
AMERICAN SPRING & PRESSING WORKS	India	Aspee Bolo		10						Villiers L34	1.2hp	1.5	11.3
ARIMITSU INDUSTRY CO.	Japan	GMD 602	6	25	3.7		45	60		KH1 TA-51 MX	3.1ps	1.8	11.6
R. & F. BERTANI	Italy	SP71	2	12				12-18		2-stroke single cylinder	3.5hp	1.25	12
BIRCHMEIER & CO.	Switzerland	SP71	1	12	0.181	6-8	0.5	15	12	ILO	3.3hp	2.2	
BUFFALO TURBINE AGRICULTURAL EQUIPMENT	U.S.A.	Mity Mite	1	13.2	3.8		1.8					0.5	9.9
F.lli GIACOMO & LUIGI CARPI	Italy	Fedit Superleggere	2	11	2.7	5	2.5	9-11	9-11	CA 80	4hp	1	9.9
CARUELLE	France	K90	2		1.51		2.5	17	14	2-stroke	4.5hp		15.5
CHINA NATIONAL AGRICULTURAL MACHINERY IMP/EXP CORP.	China	3 MF-3	1	13	0.38			12-35	9-17	IE 50 F-1	3hp		
CIFARELLI RAFFAELE	Italy	Nuvola	4	14	0.5	13	5	17-25	15-22	Cifarelli C7	5hp	2	11.4
COLINAGRO S.A.	Colombia	M-D 140	1	13				9	6	SAE/ 25:1	2.8hp		9
COOPER PEGLER & CO.	U.K.	Hurricane Minor	2	12.5				9.5	7.5	sp35	3.2hp		9.1
GLORIA WERKE GmbH	W. Germany	37	1	13	3.2		1	10	8	2-stroke	1.7hp		10
HATSUTA INDUSTRIAL	Japan	Blomic AMI5 II	6	16	3.5	12	4			Air cooled 2 cycle		1.2	9.8
HARTVIG JENSEN	Denmark	MRY-4.5		12		no dusting		17	12		4.5hp		
HOLDER	W. Germany	Supra 76	2	10	5			16		ILO engine		1.1	11.2
HOMECO	Holland	MR 3	2	11	1.71			14	9	JLO SP71	3.1	1	10.7
JACTO	Brazil	PL-45 BV	2	13	3.4	10	4.9			2-stroke air cooled		1.3	12.5
KIORITZ CORP.	Japan	DN-9	1	10	3.5	9	5	12-20	9-16		3.2hp		9.8
KOREA TRADE PROMOTION	Korea	AM-150	3	13				7.3			1.5ps		12.8
KUBOTA	Japan	AD 30	6	13	3.5		6			VK37	2.5hp	12	9.6
K.W.H. WHIRLWIND	Netherlands	S70	2	10				13	11	ILO-L70	3.5hp		
MARAHASHTRA AGRO. IND. DEV. CORP.	India	Krushi Udyog											
MAKINA VE KIMYA ENDUSTRISI KURUMU	Turkey	Sekil 1	1	13.4				5					14
MARUNAKA SPRAYER & DUSTER M.F.G.	Japan	MD 501	3	22		9				Kawasaki electric	4ps		12
MESTO SPRITZEN FABRIK	W. Germany	3510 Superbio	2	12.5	3.2		3	11	9	JLO SP71 2-stroke	4.5hp	1.25	10
MOTAN	W. Germany	Fontan R12-S	3	10	2.08		1.5	12	10	ILO SP71 2 cycle	4hp	1.2	11
MORAVA	Yugoslavia	AM-12	1	12				10		2-stroke single cylinder			10.5
MOTOSTANDARD	France	K90	2				2.5	15.17	12.14	2-stroke	5hp		12
NIR-DAVID-MOBILE	Israel	SP71 Silon	2	10						JLO 2 cycle	3.1hp	1.25	11.2
NITTO-SEISAKUSHO	Japan	NDM-375	3	12	3.3	7.5	4.2	13-17		Air cooled 2 cycle	3hp	1.2	9
PHYCO	Netherlands	FAN-71	2	11	1.71	no dusting		14	9	JLO SP71	5hp	1	10.7
CARL PLATZ	W. Germany	Boss 76	2	10	4.17					JLO SP71			10.4
PRAPOPOULOS BROS.	Greece	Mercury	2		3			12	9	JLO 2-stroke L77	3hp	1.6	15
R.C.M.	France	Goldair 1360	3					12-15	8-9	A5 type	4hp		10.5
SIGMA STEEL IND.	India	Power sprayer cum. duster	1	10	1	7.4		9-16		2-stroke air-cooled		1	12.8
TECHNOHAC AGRIC. MACHINERY & IMPLEMENTS.	Israel	Silon SP71	2	10						JLO 2 cycle	3-1hp	1.25	11.2
VANDERMOLEN	U.S.A.	Super 88	2	22.7	3.8				12	2 cycle air-cooled single cylinder		1.25	12
WEST BENGAL AGRO.-IND.	India	Benagro	1	10	2.5	8	1.5	10-11	8-9	Villiers/ Ralli	1.2-1.8	1.25	12

NB. Notes for this Table.
1. Where a range of models is available, the specifications given are generally those of the largest model.
2. Unless otherwise stated, the engine is petrol.
3. Horizontal/vertical range. Where is range is given eg 9-16m, the first figure is for spraying, the second for dusting.



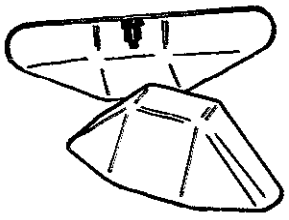
TREE GUARDS

These are for spraying herbicide around small saplings and can be attached to the end of knapsack sprayer lances. They comprise a shield with 2 or more nozzles which spray around the outside of the shield.

POLITEC TREE GUARD This fibre glass shield comes with nozzles and can give a spray width of 1.2m. Fits on a SA04-603 brass trigger on CP3 Falcon.

COOPER PEGLER & CO LTD.
Burgess Hill
Sussex RH15 9LA, U.K.

Mk 2 ARBOGARD This hand-operated sprayer has a 30cc per stroke brass pump, 2 (red) Polijets, 20 gauge aluminium sheet for the guard, supporting frame of aluminium tube and light gauge galvanised steel, and 18 litre capacity knapsack container (left).
E. ALLMAN & CO. LTD.
Birdham Road, Chichester
Sussex PO20 7BT, U.K.



SPRAY SHIELDS

These usually include a nozzle, can be mounted on the end of spray lances and restrict the area sprayed to that covered by the shield with little possibility of drift. This is very useful for spot weeding or spraying close to plants with general broad spectrum herbicides like paraquat or glyphosate. It must be noted, though, that some phytotoxicity of the crop plant could occur if weed leaves wetted with herbicide touch the crop plants. As well as manufacturers already on this page (Allman, American Spring, Cooper-Pegler Gloria-Werke) shields are available from:

ETS. P. BERTHOUD
69220 Belleville-sur-Sâone
Rhone, FRANCE

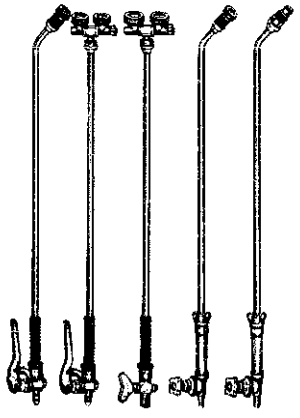
MÁQUINAS AGRÍCOLAS JACTO S.A.
Rua Dr. Luiz Miranda 5 1650
Caixa Postal 35, Pompéia S.P., BRAZIL

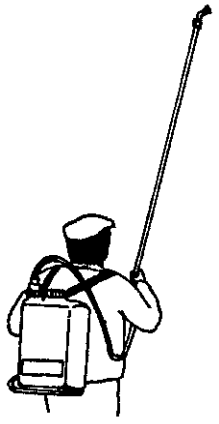
LURMARK LTD.
Longstanton
Cambridge CB4 5DS, U.K.

MESTO SPRITZENFABRIK GmbH
Postfach 66, 7141 Freiberg/Neckar
W. GERMANY

CARL PLATZ GmbH
POB 446, Wormser Straße 119
6710 Frankenthal/Pfalz
W. GERMANY

TECHNOMA
54 rue Marcel Paul, B.P. 195
51206 Epernay, FRANCE





SPRAY LANCES

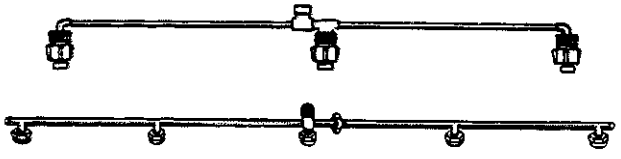
Most manufacturers provide a wide range of spray lances and triggers or other hand operated cut-off devices.

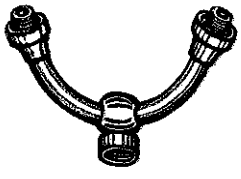
Lances can range from about 60cm (see left) to about 3m (see above) which is useful for spraying tree crops. Clearly safety hazards increase when the spray is ejected at a height and extra precautions may be needed.

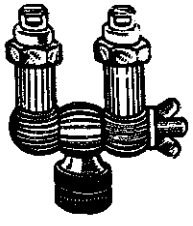
The spray lances can have a variety of cut-off devices. In the diagram these examples range (left to right) from a trigger valve, to a stopcock, to a conventional screw-threaded tap. The lance may be straight or bent at one end. Various nozzles can be added including multiple nozzle sets. A pressure gauge or pressure regulator may also be incorporated after a small strainer or filter. This is put in the system as a final protection for the nozzle jet. Manufacturers include:

COOPER PEGLER & CO. LTD.
Burgess Hill, Sussex RH15 9LA, U.K.

AMERICAN SPRING & PRESSING WORKS PVT. LTD., P.O. Box 7602
Adarsh Housing Society Road
Malad, Bombay 400 064, INDIA







BOOMS & NOZZLES

The large variety of booms and nozzles supplied by nearly every manufacturer of knapsack sprayers reflects the range of chemicals used and crops upon which they are to be sprayed. Illustrated above are a 1.5m wide 5 nozzle boom manufactured by American Spring and a 0.9m wide 3 nozzle T Boom from Cooper Pegler. Two alternative double nozzles from American Spring are illustrated above and a 'cotton tail' boom is illustrated left.

AMERICAN SPRING AND PRESSING WORKS PVT. LTD.
P.O. Box 7602
Adarsh Housing Society Road
Malad
Bombay 400 064
INDIA

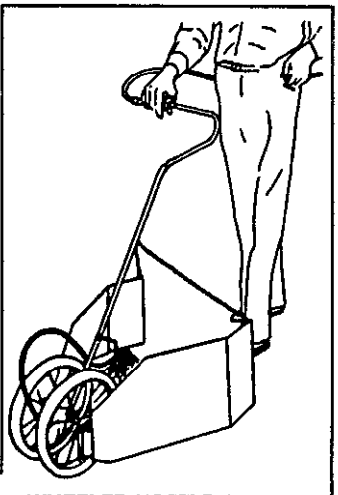
COOPER PEGLER & CO. LTD.
Burgess Hill
Sussex RH15 9LA
U.K.

GLORIA WERKE
Postfach 1160
4724 Wadersloh/Westf.
W. GERMANY

SPRAY RIGS

Many manufacturers offer spray rigs which can be attached to the end of a spray lance to ensure proper coverage of the sides of plants and lower surfaces of leaves. A 30 × 20cm rig is also available.

AMERICAN SPRING & PRESSING WORKS PVT. LTD., P.O. Box 7602
Adarsh Housing Society Road
Malad, Bombay 400 064, INDIA



WHEELED NOZZLE CARRIER

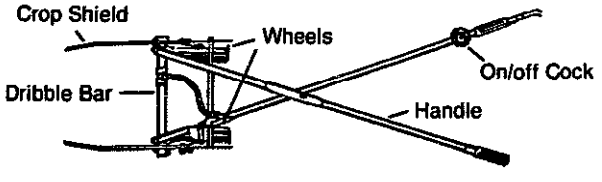
Used for inter-row weeding in conjunction with conventional knapsack sprayer. Nozzle height adjustable 127mm-380mm. Leaf guard adjustable 200mm-460mm. At 3 kph 10 litres of spray will cover 400 linear metres (illustrated above).

COOPER PEGLER & CO. LTD.
Burgess Hill
Sussex RH15 9LA
U.K.

THE EXPANDO

This is a telescopic dribble bar mounted between movable handles which are fitted with crop shields, constantly adjustable for varying inter-row widths. The machine is supported by two small wheels and is propelled by hand. The diagram below shows an aerial view.

E. ALLMAN & CO. LTD.
Birdham Road
Chichester
Sussex PO20 7BT
U.K.



HAND GRANULE APPLICATOR

The applicator is aimed at the target and when the trigger is pressed a measured amount of granules is released. This amount is determined by two cones which can be altered to provide variations. A connecting rod agitates the granules and prevents blocking.

Main advantages:
Granules can be accurately placed on target
Quantities can be adjusted to suit applications
Adaptable for spot or continuous band treatment
Constant granule agitation
Two models are available
Model 10 — 0.5gm approximately
Model 20.5 — 1gm approximately
Capacity 1.7 litres
Overall length 104cms

HORSTINE FARMERY LTD.
North Newbald, Yorkshire YO4 3SP
U.K.

SHOULDER-SLUNG GRANULE APPLICATORS

Many herbicides are now available in granular form and can be spread by these types of applicator. They can also be used for seed broadcasting and fertilizer spreading. Among various manufacturers the following are listed:

NGI GRANULE APPLICATOR The special design (illustrated right) which incorporates a 12 bladed impeller, provides more uniform distribution of herbicides, fertilizers and seeds. Granulated chemicals are dispersed from the right, forward and to the left at a maximum distance and uniform volume. It covers a 6 metre width with an average belt of 1.2 metres around the operator. Weight: 2.5kg. Tank capacity: 8.0 litres. Handle rotation: 80rpm.

HATSUTA INDUSTRIAL CO. LTD.
4-38 1-chome, Chifune
Nishiyodogawa-ku, Osaka, JAPAN

GRANULE SPREADER AP-3:

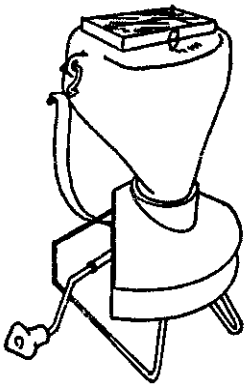
ARIMITSU INDUSTRY CO. LTD.
3-21 Fukaekita 2-chome
Higashinari-ku, Osaka 537
JAPAN

GRANULE SPREADER THREE STAR C-10 Capacity: 8 litres. Weight: 2.5kg. Dimensions: 410mm × 260mm × 450mm.

MARUNAKA SPRAYER & DUSTER MFG. CO. LTD.
11 Makaida Nishimachi
Kisshoin, Minamiku, Kyoto
JAPAN

MULTI-PURPOSE SPREADER T-7 This spreader has a directional discharge opening to direct the broadcast material. Its specifications are: Capacity: 7 litres. Weight: 2kg. Size: 233mm × 420mm × 405mm.

OHMAE MANUFACTURING CO. LTD.
21-1 Akabane, 3-chome
Kita-ku, Tokyo 115
JAPAN



PROCALL DUSTER

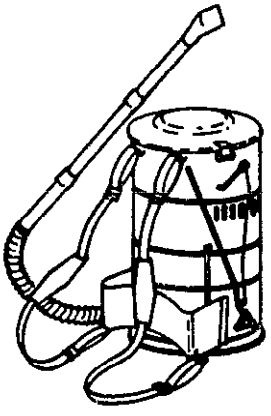
This hand duster (illustrated left) is used for the accurate application of plant and weed control granules. Capacity: 8.5 litres. Output: up to 0.82kg/minute. Weight: 4.6kg.

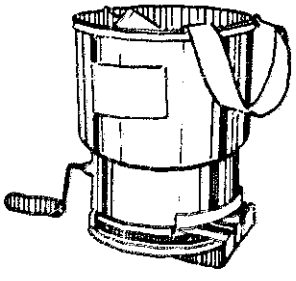
ETS. P. BERTHOUD
69220 Belleville-sur-Saône
Rhone
FRANCE

PJC KNAPSACK DUSTER

This duster (illustrated right) can deliver micro-granules or dust across a swath of 5m. Weight: 7kg. Tank capacity: 8kg.

MÁQUINAS AGRÍCOLAS JACTO S/A
Rua Dr. Luiz Miranda 5 1650
Caixa Postal 35, Pompéia S.P.
BRAZIL





ROTARY GRANULE APPLICATORS

SEYMOUR No. 75 UNIVERSAL SPREADER This applicator (illustrated left) can be used for precision broadcasting. It has a 10 point calibrated scale, with an adjustable opening to control swath width. Weight: 2.7 kg.

SEYMOUR MAN. CO. INC.
500 North Broadway, P.O. Box 248
Seymour, Indiana 47274
U.S.A.

ASPEE ROTARY GRANULE APPLICATOR This model has a high density polythene hopper, metal gears and a plastic rotor. Spray width: 6m. Weight: 2.8kg. Recommended rpm. 40.

AMERICAN SPRING & PRESSING WORKS PVT. LTD.
P.O. Box 7602
Adarsh Housing Society Road
Malad, Bombay 400 064
INDIA

ZINCK SPREADER Made from polypropylene and nylon. Capacity: 5kg, 3 setting adjuster, up to 4m swath.

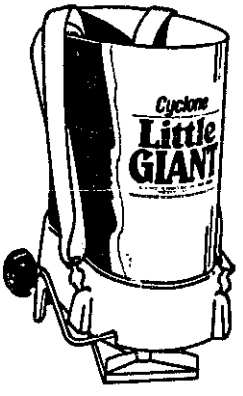
ZINCK'S FABRIKER A/S
Godthaab, Jylland
9230 Svenstrup J
DENMARK

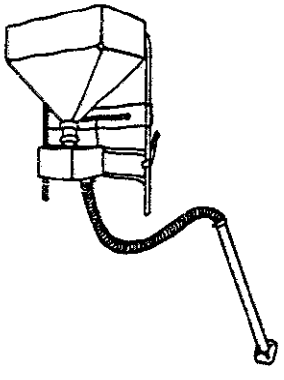
CYCLONE X2A LITTLE GIANT This spreader (illustrated right) is made from high density polyethylene. The spread is relatively narrow. There is also available the X1A commercial wide spread model.

VICTA (U.K.) LTD.
Rutherford Road, Daneshill West
Basingstoke, Hampshire RG24 0QY
U.K.

MODEL 20A This is similar to the Cyclone above.

BOB ANDREWS LTD.
Pontiac Works, Fernbank Road
Ascot, Berks.
U.K.



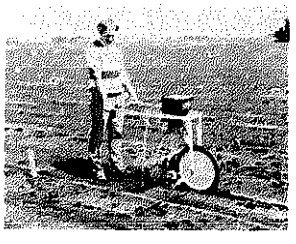


SPOT TREATMENT KNAPSACK GRANULE APPLICATOR

The machine is designed for the application of granular herbicides, pesticides, and fertilizers in single shot doses to individual plants, shrubs, trees etc. The calibration unit is variable and can be set for doses of 5cc to 60cc in 5cc steps. Once calibrated, the unit will apply the same dose consistently. The machine weighs 6.3kg empty and holds approx. 10kg of chemical (depending on density). It is equipped with a comfortable frame and harness for mounting on the operator's back.

Material can be applied directly from the outlet tube. Impact spreaders are available for a spread distribution on the ground, or steel tube ends so that the material can be incorporated with the soil.

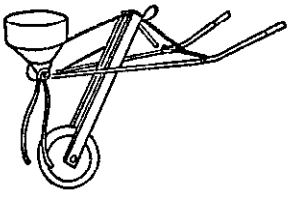
HORSTINE FARMERY LTD.
North Newbald, Yorkshire YO4 3SP
U.K.



GANDY LINE TENDER

Applies granules accurately. Available in 2 models for 2.5 to 7.5cm banding or for 17.5cm Ro-bander option. Capacity: 12 litres.

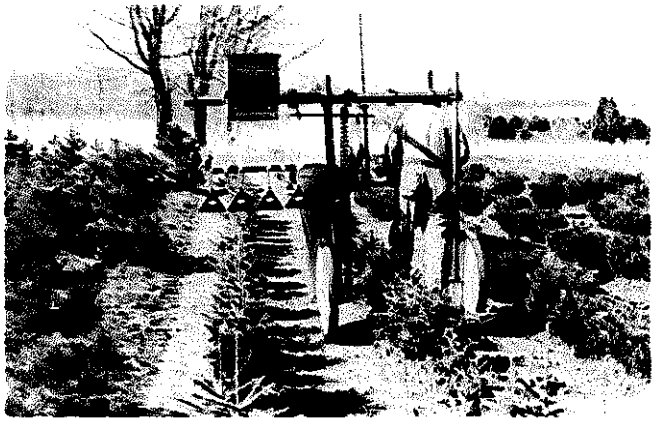
GANDY COMPANY
528 Gandrud Road, Owatonna
Minnesota 55060
U.S.A.



WHEELBARROW APPLICATOR

Plastic hopper of 32 litre capacity delivers granules via two 2.5cm bore plastic pipes. Applicator is chain driven by a centrally mounted landwheel. 2 application rates available.

HORSTINE FARMERY LTD.
North Newbald, Yorkshire YO4 3SP
U.K.

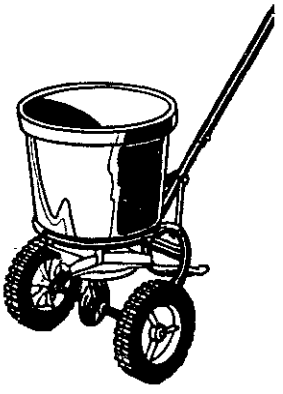


RO-HI PRECISION APPLICATOR

Up to four 18cm Ro-banders can be used giving maximum width of 72cm. There is a rope controlled shut-off. The standard model has a clearance of 67cm. The 2 person handle can be offset to one side.

Capacity: 20kg. Wheels: 67cm disc type with semi-pneumatic rubber tyres; Flo-control rotor; five bladed steel, precision-moulded neoprene. The tubes can be extended to deliver granules to the base of plants.

GANDY COMPANY
528 Gandrud Road, Owatonna
Minnesota 55060
U.S.A.



2-WHEELED CYCLONES

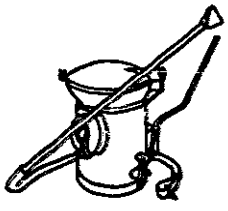
Both Bob Andrews and Victa produce/distribute a wide range of 2 wheeled cyclones which can be used for many purposes. (See Section 4 for further models). Two models are described below.

96-83 CYCLONE This model (illustrated above) can be pushed by hand. It has a capacity of about 18kg and has 20cm heavy duty plastic wheels. The swath width is adjustable between 1.20m and 2.40m. Weight about 7kg.

VICTA (U.K.) LTD.
Rutherford Road, Daneshill West
Basingstoke, Hampshire RG24 0QY
U.K.

STANDARD B1 MODEL Similar size of model with spread width of 1.90m.

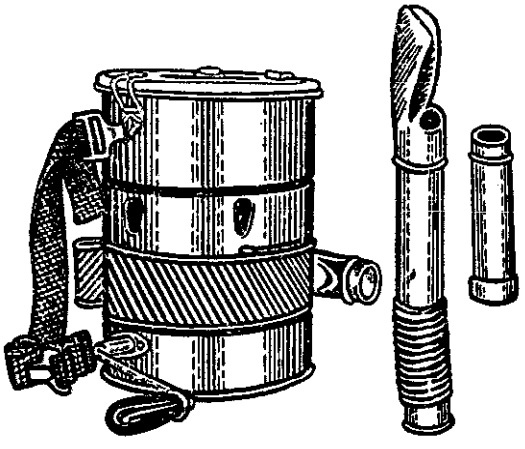
BOB ANDREWS LTD.
Pontiac Works, Fernbank Road
Ascot, Berks.
U.K.



PETIT JAUNE DUSTER

This duster or sulphur spreader is single acting and has a weight of 4.3kg. Also available is the Eclipse duster which holds 7kg and has a net weight of 5.5kg.

ETS. P. BERTHOUD
69220 Belleville-sur-Saône
Rhone
FRANCE



HAND ROTARY DUSTERS

Various manufacturers of a range of hand rotary dusters are listed below.

ASPEE JUBILEE ARD-10 This duster has a 5 litre capacity hopper and weighs 4kg.

AMERICAN SPRING & PRESSING WORKS PVT. LTD.
P.O. Box 7602
Adarsh Housing Society Road
Malad, Bombay 400 064
INDIA

HAND DUSTER HD-7 This duster has a 4.5 litre capacity hopper and weighs 3kg. It can reach 6 to 10 metres and has an outlet capacity of up to 0.55kg/m. A variety of outlet pipe accessories are available.

ARIMITSU INDUSTRY CO. LTD.
3-21 Fukaekita 2-chome
Higashinari-ku, Osaka 537
JAPAN

KRUSHI KR-2 DUSTER This is a similar duster with an adjustable strap.

ASIAN AGRICO INDUSTRIES
Post Box No. 29, Gandevi Road
Billimora (W-Rly) 396 321, Gujarat
INDIA

VDO 5-LITRE This duster has a 5 litre metal hopper, a gearbox mounted on roller bearings and an adjustment flap to control output. Fan speed is about 12m/sec. and for powders a discharge rate up to 0.45kg/m is obtainable. Also useful for granules. Weight: 3.2kg.

ETS. P. BERTHOUD
69220 Belleville-sur-Saône
Rhone
FRANCE

MODEL T/8 G Large capacity hopper holding around 2.5kg of powder or 3.5kg of granules. Rated hand revolution 80rpm. Dust can reach 8m. Full container average working period is approximately 30 minutes. Adjustable output control is available. Weight: 3kg.

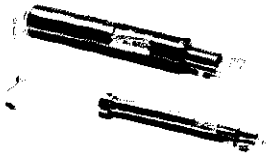
KIORITZ CORPORATION
5-1 Shimorenjaku 7-chome
Mitaka, Tokyo 181
JAPAN

AMIT HAND ROTARY DUSTER This model (illustrated) has a 5 litre capacity hopper, mechanical agitator and full discharge control. It comes with a flexible lance, spreader nozzle and adjustable shoulder straps.

KRUSHI VIKAS SADAN KENDRA
Opp. Town Hall
Bulsar Valsad 396 001, Gujarat
INDIA

MODEL D-7 Suction style hand operated duster; high revolution ventilator fan; die-cast gear case and worm-gear with sealed bearings. Chemical agitator. Hopper capacity: 4kg. Discharge capacity: 550g/min at opening 4. Hand revolution: 65rpm average. Blower: 11.5m/sec. Weight: 3kg.

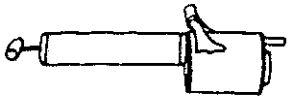
MARUNAKA SPRAYER & DUSTER MFG. CO. LTD.
11 Makaida Nishimachi, Kisshoin
Minamiku, Kyoto
JAPAN



DUST-R & MINI-DUST-R

The Dust-R (lower illustration) has a large 2.5 litre reservoir. Output can be regulated. The Mini-Dust-R has extension tubes and special outputs, to enable it to spread dust into difficult corners.

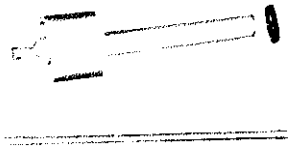
B & G EQUIPMENT CO.
P.O. Box 130, Applebutter Road
Plumsteadville
Pennsylvania 18949-0130
U.S.A.



CHAPIN HAND DUSTERS

2.5 litre duster of length 130cm. Piston-operated. Large filler opening. 45cm extension tube with spreader. Also available 3 smaller models.

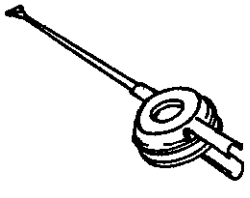
HOCKMAN-LEWIS LTD.
200 Executive Drive
West Orange, NJ 07052
U.S.A.



No. 465 PLUNGER DUSTER

Container holds 400g of dust. Pump-operated. Has long extension and swivel-type flat fan nozzle for broadcast, higher volume dusting. Weight about 400g. Another small model is available.

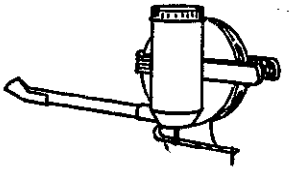
ROOT-LOWELL CORPORATION
Lowell, Michigan 49331
U.S.A.



BELLOWS SULPHURATOR

It is made of shock-resistant plastic material. 0.6kg capacity tank.

R. & F. BERTANI
Via Leonardo da Vinci, N.41
20061 Abbiategrasso, Milano
ITALY



GIGANTE

This bellows duster is equipped with a long discharge tube and powder distributor. The tank capacity is 1kg of dry powder.

F.lli GIACOMO & LUIGI CARPI
42028 Poviglio, Via Romana 82-R.E.
ITALY

HAND-HELD ROTARY DUSTERS

Below are listed various manufacturers of a range of hand held rotary dusters. These are all very similar and have tank capacities of around 0.4kg; a range of about 2.5m; handle rotation speed of 70rpm; adjustable output; and a weight of about 0.7kg.

ARIMITSU INDUSTRY CO. LTD.
3-21 Fukaehita 2-chome
Higashinari-ku, Osaka 537
JAPAN

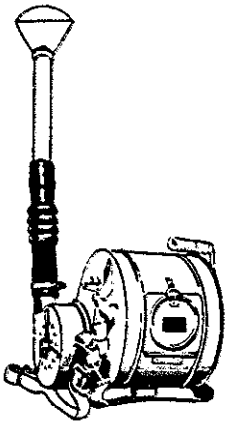
CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

HATSUTA INDUSTRIAL CO. LTD.
4-39 1-chome, Chifune
Nishiyodogawa-ku, Osaka
JAPAN

KIORITZ CORPORATION
5-1 Shimomeguro 7-chome
Mitaka, Tokyo 181
JAPAN

MARUNAKA SPRAYER & DUSTER MFG. CO. LTD.
11 Makaida Nishimachi
Kashoin, Minamiku, Kyoto
JAPAN

NITTO SEISAKUSHO CO. LTD.
29-3 3-chome Noe, Jyotoku
Osaka
JAPAN



NECK-SLUNG HAND ROTARY DUSTERS

HAND ROTARY DUSTER Two models are available which conform to Indian Standards (illustrated left). One model is shoulder mounted, the other is mounted on the front of the operator ('belly mounted') with a strap around the operators neck, and in this design allows easy operation, by the right hand, of the hand-operated fan.

WEST BENGAL AGRO INDUSTRIES CORPORATION LTD.
23B Netaji Subhas Road
3rd Floor, Calcutta 700 001
INDIA

HAND OPERATED DUSTER MRZ-14 This Yugoslavian model has a 14 litre plastic fibre or aluminium box. The axial flow ventilator fan has an air output of 0.02m³/sec and an air outlet speed of 10.6m/sec. Dusting width is 5m. Weight of empty duster 6.2kg.

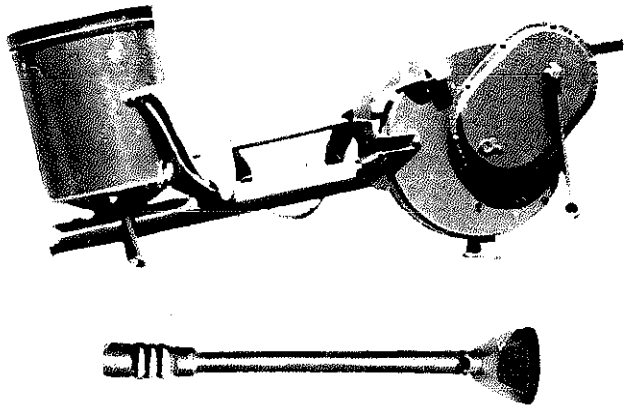
MORAVA
Servisna Sluzba, 1200 Požarevac
Djure Djakovića BB
YUGOSLAVIA

No. 599 CRANK DUSTER This is a compact durable duster that moves a large volume of air. Discharge rate is variable between 1 to 15kg/ha. Hopper capacity is 4kg. Spiral agitator prevents packing and clogging of dust in hopper.

HOCKMAN-LEWIS LTD.
200 Executive Drive
West Orange, NJ 07052
U.S.A

MODEL 1031 ROTARY DUSTER This is a similar model which is economical and easy to use. Adjustment is quick. Hopper contains about 3.5kg of average density dust. Rotation fan case which allows front or rear dusting. Dust proof sealed bearings. Weight about 6.5kg.

ROOT-LOWELL CORPORATION
Lowell, Michigan 49331
U.S.A.



SHOULDER-MOUNTED HAND-OPERATED ROTARY DUSTER

These are rotary dusters for warehouses, crops, trees etc.

HAND ROTARY DUSTER Used for all types of powdered insecticides. It has a galvanized steel hopper of 7 litres capacity with a mild-steel fan casing and fan impeller. The lance is made from galvanised steel. Crank can be turned at up to 80rpm at which speed the air output is 1.5m³. Weight: 7kg.

SIGMA STEEL INDUSTRIES (REGD.)
A-2 Industrial Estate
Ludhiana 141 003, Punjab
INDIA

ORIENT HAND ROTARY DUSTER ORD-1 This well-balanced duster is fitted with a breast-plate for comfortable operation. It is supplied with a flexible hose coupling, metal lance, spreader nozzle and adjustable shoulder strap.

AMERICAN SPRING & PRESSING WORKS PVT. LTD.
P.O. Box 7602
Adersh Housing Society Road
Malad, Bombay 400 064
INDIA

KRUSHI HAND ROTARY DUSTER KR-3 This model is similar to that produced by American Spring.

ASIAN AGRICO INDUSTRIES
Post Box No. 29, Gandevi Road
Billimora (W-Rly) 396 321, Gujarat
INDIA

No. 79 ROTARY HAND DUSTER Another similar model with a tank capacity of 5kg.

KUMAON NURSERY
Ramnagar — 244 715
Nainital, U.P.
INDIA

HAND DUSTER

These dusters are designed for blowing poison into rat nests. Tank capacity: 1.7 litres. Total weight about 1.7kg.

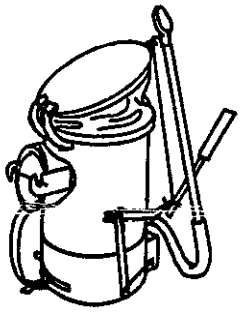
P.T. PURNA SADHANA
Jl Asia Afrika 150, Bandung
INDONESIA

BIRO TEKNIK M. DJUPRI
Jalan Ronggowarsito, Solo
INDONESIA

PRES-TO-BLO DUSTER

The stainless steel tank holds about 4kg of powder. A compressed air source is used to pressurise to about 7kg/cm². On squeezing lever up to 2kg of powder is released in 20 seconds. The blower weighs only about 3kg. It is supplied with a 7.5m flexible hose. It is particularly useful for injecting insecticides into crevices and roof spaces of warehouses.

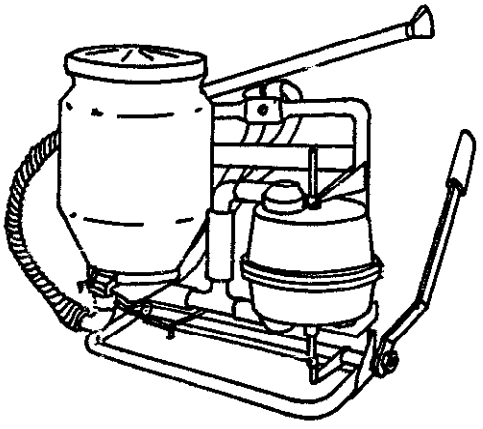
B & G EQUIPMENT CO.
P.O. Box 130, Applebutter Road
Plumsteadville
Pennsylvania 18949-0130
U.S.A



KNAPSACK HAND DUSTER 801

This duster (above) has a plastic body and an output up to 0.2kg/min. Tank capacity is 10kg and it weighs 7.5kg (gross). The hand-lever operated bellows are mounted above the plastic-bodied tank.

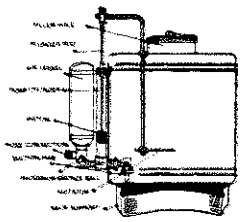
P. PRAPOPOULOS BROS.
Metallurgy S.A., 275 Corinthou
Perivola, Patras
GREECE



SPEEDAIR-CIDUE

This knapsack duster (left) has an external diaphragm air pump operated by a lever placed on left or right. The polythene tank has an agitator and the output has 5 position regulator. Net weight: 4.9kg.

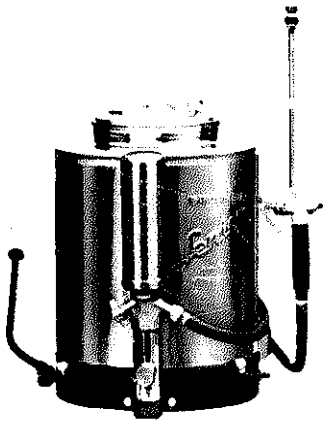
F.lli GIACOMO & LUIGI CARPI
42028 Poviglio, Via Romana 82-R.E.
ITALY



EXTERNAL PUMP KNAPSACK SPRAYER

All brass knapsack sprayer with 16 litre tank and pump handle on left. Spray-gun has two nozzles.

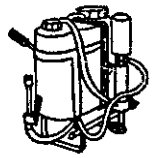
VANDERMOLEN CORP.
119 Doras Avenue, Livingston
NJ 07039
U.S.A.



BIRCHMEIER EXTERNAL PUMP KNAPSACK SPRAYERS

Birchmeier produce seven external pump knapsack sprayers, made from brass and steel. They have large openings with tight-fitting bayonet lids with filter. The diameter of the piston is 37mm. The trigger cock is made of solid brass and can be held open by a clip. Each sprayer is equipped with two flood jets for precision application of herbicides and one nozzle (Duro) for pesticides. An extending lance (1 to 2m) is available as is a 4 nozzle spray-boom for herbicide application with a spray width of 136cm. Working pressure: 6 bar. Max. rate of discharge: 2 litres/min. Tank capacity: from 10 to 20 litres. Weight: from 5.4 to 7.7 kg.

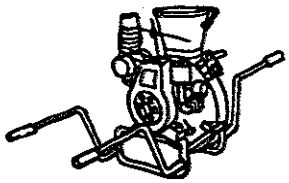
BIRCHMEIER & CO. LTD.
CH 5444 Künten
SWITZERLAND



POLYTHENE PLASTIC KNAPSACK SPRAYER

This external pump sprayer has a 15-16 litre capacity, a weight of 7kg and a right or left handle for pump. Nozzle discharge rate from 450 to 800ml/min. The spray lance and nozzle which are attached to the discharge hose on the left of the sprayer have been omitted from the drawing.

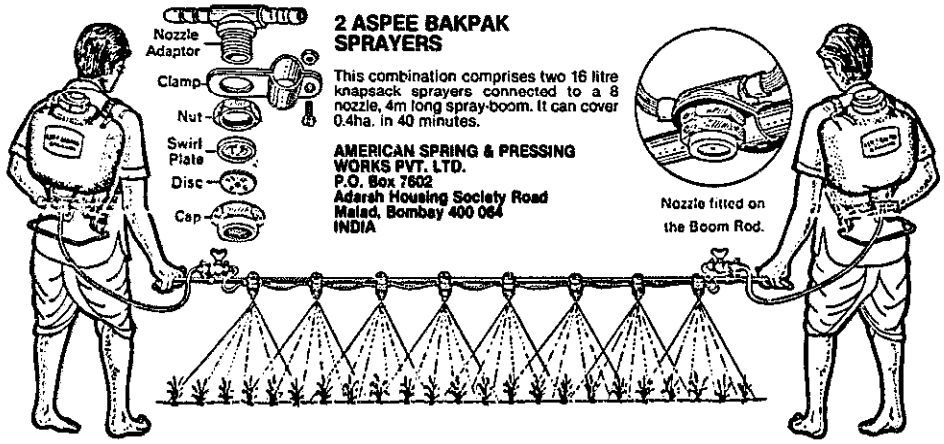
SIGMA STEEL INDUSTRIES (REGD.)
A-2 Industrial Estate
Ludhiana 141 003, Punjab
INDIA



ASPEE TREE DUSTER

Powered by 3.4hp petrol engine this duster can blow insecticides, fungicides etc. 25m into the air or 50m horizontally. Dust output: 3.5kg/min. Capacity: 28 litres. Weight: 65kg. Also available a tree sprayer for liquids.

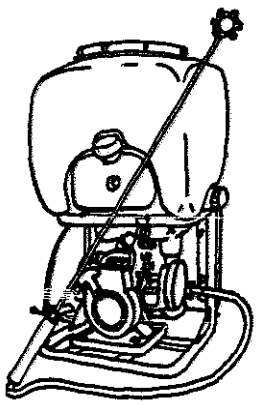
AMERICAN SPRING & PRESSING WORKS PVT. LTD.
P.O. Box 7602
Adarsh Housing Society Road
Malad, Bombay 400 064
INDIA



2 ASPEE BAKPAK SPRAYERS

This combination comprises two 16 litre knapsack sprayers connected to a 8 nozzle, 4m long spray-boom. It can cover 0.4ha. in 40 minutes.

AMERICAN SPRING & PRESSING WORKS PVT. LTD.
P.O. Box 7602
Adarsh Housing Society Road
Malad, Bombay 400 064
INDIA



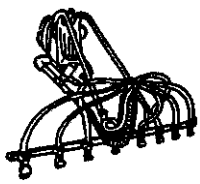
JAPANESE BACK-PACK POWER SPRAYERS

The following manufacturers produce similar types of back-pack powered sprayer. They comprise a 20 to 22 litre tank which is constantly agitated by a jet stream from the water in the pump. Pump pressure maximum is 21kg/cm². A variety of nozzles can be used at high pressure using, especially, the circular 'Penta' nozzle, with a low pressure 'Epock' nozzle being used for herbicide spraying. Powered by a 2 stroke air cooled engine, it weighs, according to model, between 7 and 9kg when empty.

HATSUTA INDUSTRIAL CO. LTD.
4-38 1-chome, Chifune
Nishiyodogawa-ku, Osaka
JAPAN

KUBOTA LTD.
2-47 Shikitsuhigashi 1-chome
Naniwa-ku, Osaka 556-91
JAPAN

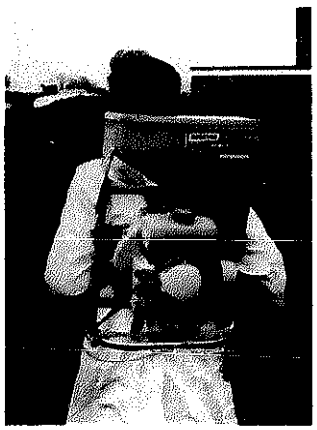
NITTO SEISAKUSHO CO. LTD.
28-23 3-chome Noe
Jyotoku, Osaka
JAPAN



GRANULOR MOTORIZED KNAPSACK GRANULE SPREADER

Used for powered spreading of granules, this 8 nozzle machine can cover a width of 1.5-2m. Total weight: 18.3kg. The motor is mounted on the operator's back and the operator holds the boom to the front.

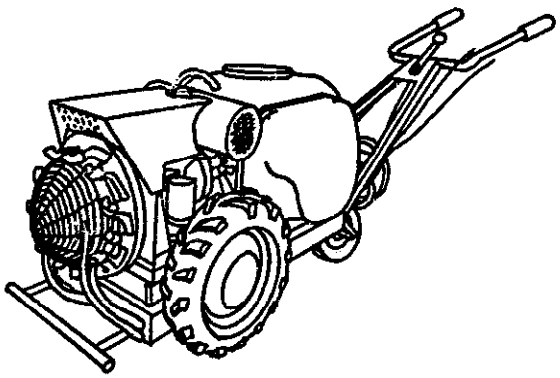
FISCHER S/A
1801 Fenil-Vevey
SWITZERLAND



MOTORIZED KNAPSACK GRANULE APPLICATOR

The Motorized Knapsack applicator has a glass fibre self-emptying hopper, feeding a calibration unit comprising of an on/off slide mechanism and interchangeable multi-hole discs, each giving a range of predictable outputs. The hand operated on/off control, for spot or band treatment, and the engine speed control, are both mounted on an arm for ease of operation. This model weighs only 10kg and is supplied with a harness designed for operator comfort. The standard fishtail outlet gives spreads up to 1m wide and the engine output is restricted to avoid drift.

HORSTINE FARMERY LTD.
North Newbald, Yorkshire YO4 3SP
U.K.



SELF PROPELLED MIST BLOWER — URGENT 110

The Urgent 110 is equipped with an engine of 8.3hp. This powerful engine drives a well balanced fan made of one piece giving an enormous air-output which is imperative for an efficient protection of orchards, vineyards, and other crops such as cotton, tobacco, tomatoes and many more.

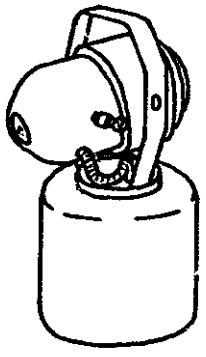
Air velocity: 100m/sec. Air output: 2600m³/h. Radius: ± 15m. Speeds: 1 forward, 1 reverse, speed adjustable from 0.4-4.7km/h. Tank: made of seamless polyethylene; capacity 110 litres. Nozzles: 6 adjustable in all directions. Accessories: dusting attachment, sprayboom for weedkilling between the rows. Wheeltrack: 650 or 770mm.

HOMECO B.V.
Industrielaan 16, P.O. Box 66
6950 AB Dieren
NETHERLANDS

ATOMIZERS 323-1

Atomizers for intermittent and continuous action give a very fine spray borne by a powerful airstream to the target. For the control of flying insects, disinfection, air humidifying, etc. Powerful pump made of solid brass with 1 litre durable plastic container.

MESTO SPRITZENFABRIK GmbH
POB 66
7141 Freiberg/Neckar
W. GERMANY



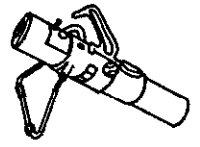
FOGMASTER 7401 MICRO-JET ULV FOGGLR

Over 64 per cent of the spray particles dispersed by the 'Micro-jet' fogger are in the 7 to 10 micron range, providing you with a more efficient use of your insecticide solution.

A special, fully adjustable control valve allows you to adjust the output rate of your solutions from 0.7 litres per hour to 25 litres per hour. The discharge blast of the 'Micro-jet' allows faster coverage of large areas while reducing labour and material costs.

Motor: 110/120 volt, AC-DC universal type, 50/60 cycle, 1600rpm, continuous duty. Shipping weight: 5.5kg. Tank: 4.5 litre capacity. Other models available.

HOCKMAN-LEWIS LTD.
200 Executive Drive
West Orange, NJ 07052
U.S.A.

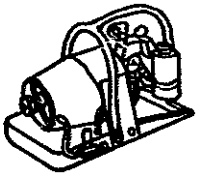


MICROSOL 101 MECHANICAL AEROSOL GENERATOR

'Microsol Model No. 101' produces aerosol size particles by a 'cold-shearing' process (high speed revolving discs ejecting radial films of liquid into a constant powerful axial air blast).

Length: 0.51m. Weight: 7.48kg. Capacity: 22.68 litres/h.

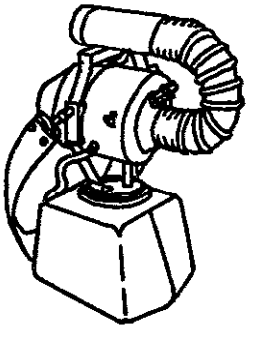
TIFA LTD.
50 Division Avenue
Millington, NJ 07946
U.S.A.



MITY MOE LOW VOLUME SPRAYER

Available in two versions powered either by petrol engine or electric motor. Horizontal range of 12m and a vertical range of 7.5m. Capacity: about 1 litre. Weight: approx. 6.5kg.

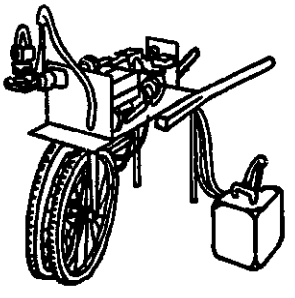
BUFFALO TURBINE AGRICULTURAL EQUIPMENT CO. INC.
Industrial Place, Gowanda
P.O. Box 150, New York 14071
U.S.A.

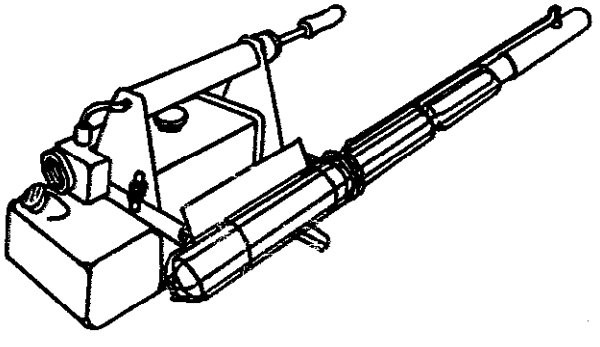


No. 1035 ELECTRIC ULV SPRAYER

Ultra low volume sprayers discharge a very small amount (low volume) of concentrated chemical in droplets of the optimum 5 to 15 microns size. These concentrated droplets will float in the air up to 5 hours. Powerful electric blower produces a strong, penetrating airblast. Simple, precise needle valve controls liquid output. The low temperature airblast does not damage chemicals as thermal foggers do. Effective discharge carry in still air: 30m. Effective discharge carry outdoors: 70m. Particle size analysis:- Mass median diameter: 9.2 microns; Average particle size: 8.5 microns; Largest particle found: 30 microns; Next largest particle: 28 microns. Other models available including 'Atomite' duster which delivers electrostatically-charged particles.

ROOT-LOWELL CORPORATION
Lowell, Michigan 49331
U.S.A.





HIGH PERFORMANCE FOG GENERATORS

Both Tifa and Motan have a range of similar portable fog generators.

SN 11-N SWING FOG This produces fog by thermo-mechanical means. Burning petrol in a combustion chamber sets up oscillation of the exhaust gases in the resonator pipe at about 80 vibrations per second. At the end of this pipe the chemical is fed into the escaping gas stream and turned into fine droplets. Chemical tank capacity: 4.5 litres. Petrol tank capacity: 1.3 litres. Output: 10-30 litres/h. Weight: 9kg. Other models available.

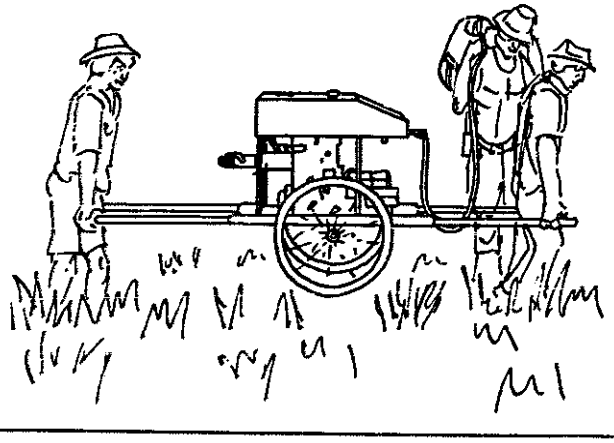
SN 100 SWING FOG POWER FOGGER This large model has a chemical tank capacity of 40 litres. Output: 40-130 litres/h. Weight: 50kg.

MOTAN GmbH
Max-Eyth-Weg 42, P.O. Box 1260
7972 Isny im Allgäu, W. GERMANY

TAPA ONE PERSON PORTABLE THERMAL FOGGER Tifa produce Tapas (illustrated above) which are designed to be used on tropical plantings, shrubbery and those difficult to reach areas where only narrow equipment can reach. The flexibility of a one-man operation, containing in the 22.5 litre plastic container sufficient chemical to treat 2ha, provides maximum utilization of man-power and greatest possible coverage of foliage or vegetation which will result in increased yield of crops produced. Weight: 56.7kg.

TIFAFOG SN12 This fogger (illustrated left) is similar to the Motan model described on the left. Chemical tank capacity: 4.5 litres. Supplementary back-pack tank: 18 litres. Fuel tank capacity: 1.3 litres. Output: 10 to 30 litres/h. Optional attachment: flame-throwing head. Weight: 9kg.

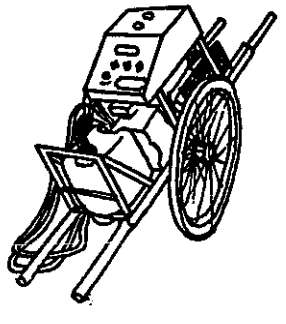
TIFA LTD.
50 Division Avenue
Millington, NJ 07946
U.S.A.

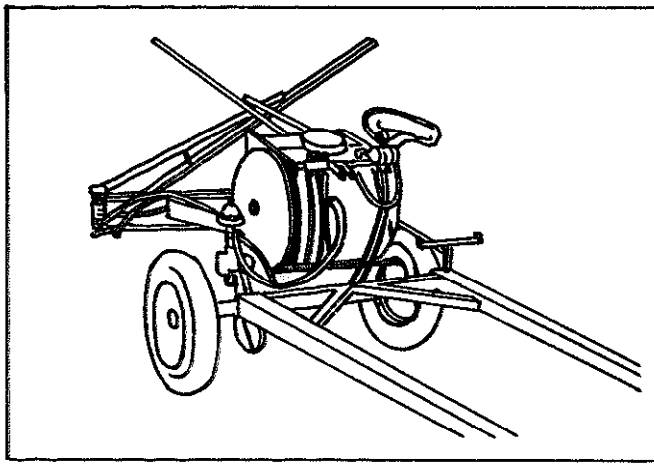


TART/TIGA FIELD APPLICATOR

This large scale applicator is included because of its usefulness in counteracting epidemics in areas of the world where smallholders own individual plots and trees within densely planted large areas of monoculture. Rapid action by a local authority could stem a serious calamity. Major outbreaks of disease and insects can be prevented and suppressed in coffee, tea, cocoa, dates, rubber, oil palm, coconuts, peppers. The efficient deposition of fungicides and insecticides can be achieved by one machine with three operators over an area of about 200ha in a day. Weight: 114kg.

TIFA LTD.
50 Division Avenue
Millington, NJ 07946
U.S.A.



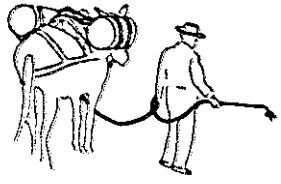


GD4419 ANIMAL-DRAWN SPRAYER

Modern farming and market gardening practices increasingly demand the use of sprays but until now the horse farmer has not had the equipment to use the large range of chemical aids developed for crop care and control. To fill this need, the GD4419 ground drive sprayer has been produced. Totally modern in design and construction, this wheel-driven sprayer is built for use with horses or to be adapted for use with mules and oxen. A 200 litre plastic tank is mounted on a box section steel chassis incorporating a 6 metre boom. The boom, easily adjusted for height, folds into 3 sections for transport, and each outer boom section has a spring loaded breakjack device to avoid damage to the boom if an obstacle is hit. The diaphragm pump is chain-driven from a differential gear box on the main axle: the axle carries 600 × 16 land drive tyres and is supported on sealed, self-aligning bearings. The differential provides continuous drive to the pump, even on corners. Full spray pressure is reached within half a wheel revolution from a stationary position. The spray mixture is delivered via an on/off tap and a pressure regulator to a further bank of 3 taps, which control the flow to a boom section to enable accurate spraying of awkward headlands. Surplus pressure from the regulator valve is used to provide continous agitation of the mixture to prevent spray chemicals from settling out and causing jet blockage and uneven application.

The machine is light and compact thus minimizing ground damage and giving access to land which, because of soil conditions or gradient, is unworkable by other mechanized systems. Each machine is supplied with calibration instructions and a range of jet sizes to suit different application rates.

CARTHORSE CO. LTD.
Egremont Farm, Payhembury
Honiton, Devon EX14 0JA, U.K.



2TG-110 PACK HORSE SPRAYER

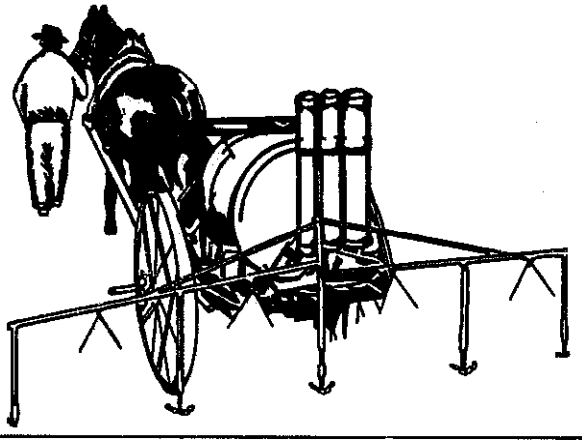
This is a pressure-retaining, hand-pumped compression sprayer outfit with two galvanized steel tanks carried on a pack animal. Total capacity of the tanks is 60 litres and the total weight with full tanks is 88kg. Working pressure: 2.4kg/cm².

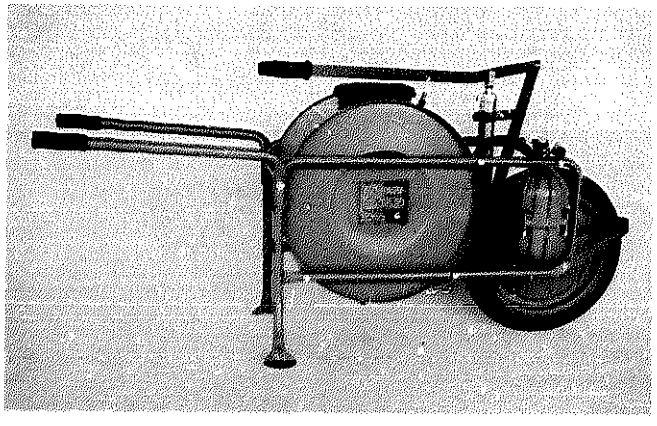
FUMIGADORAS TRIUNFO S.A.
Apartado 4045, Cali
COLOMBIA

ANIMAL-DRIVEN SPRAYER WITHOUT MOTOR

This is a high pressure (20 bar), high performance (750 litres/ha), economical sprayer. It is used for plant protection and pest-control operations, weed-killer, fungicide or insecticide treatment by spray-boom or by spray-gun for trees. The three-cylinder pump is activated by an eccentric drive of the shaft, adjustable pressure valve, pressure-gauge, shut-off valve, air chamber, injector-agitator. Steel frame, 400 litre fibreglass reinforced polyester resin tank, wheels diameter 1.1 metre, with metal ring, mobile hubs with dutch-lever axle, with wheels adjustable up to 1.5 metres. Spray-boom for 5 rows of crop interrow distance up to 70cm, can be folded and lifted. Accumulator for high pressure gun spraying.

FISCHER S/A
1801 Fenil-Vevey
SWITZERLAND





WHEELBARROW SPRAYERS

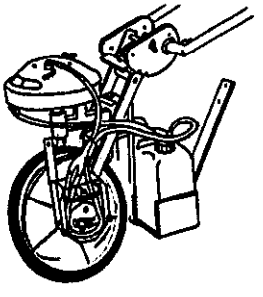
The tanks have 50 to 60 litres capacity, complete with filter, cover and mechanical agitator. The pump is piston type: oil-bath working, operated by hand. The wheel is a disc wheel of stamped plate with semi-pneumatic rubber tyre, with two bushings. Net weight of Carpi model illustrated left is 36kg.

Bertani produce the Lever Ideale and the Patented Ticino and RCM the larger Ondine 1400.

F.lli GIACOMO & LUIGI CARPI
42028 Poviglio, Via Romana 82-R.E.
ITALY

R. & F. BERTANI
Via Leonardo da Vinci, N. 41
20081 Abbiategrasso, Milano
ITALY

R.C.M.
32 Course de Verdun
38200 Vienne
FRANCE



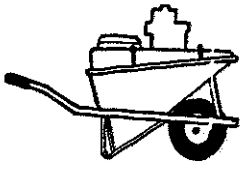
GOM WHEELBARROW SPRAYER

The GOM wheelbarrow sprayer is a herbicide sprayer for the tropics which is cheap enough for farms of less than 10 hectares and does not require large quantities of water to achieve the correct application rate. It is also small and light, for easy operation by one person, but robust enough for arduous conditions. The ground-wheel drive mechanism is trouble-free, and by linking the flowrate to walking speed minimizes the chance of incorrect dosing.

The width of spray swath is adjustable to permit inter-row use and to limit the area covered to save expensive chemicals. Droplet size minimizes the risk of drift.

Special features: Micron 'Micro-max' rotary atomizer (controlled droplet applicator) driven from land wheel. Peristaltic pump, also driven from land wheel, delivers herbicide spray to rotary atomizer at constant rate. Adjustable shroud permits a variable band of herbicide to be sprayed rearwards as the machine is pulled along. Surplus chemicals flow back into container.

GEEST OVERSEAS
MECHANISATION LTD.
Marsh Lane, Boston
Lincolnshire PE21 7RP
U.K.

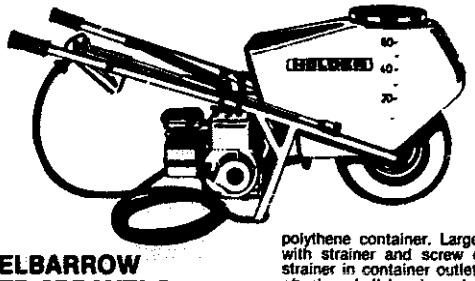


WHEELBARROW-MOUNTED MOTORIZED SPRAYERS

The following manufacturers produce similar models of wheelbarrow sprayer. The sprayer is powered by a small two-stroke engine mounted on top of the chemical tank.

HOMECO B.V.
Industrielaan 16, P.O. Box 68
6950 AB Dieren
NETHERLANDS

FISCHER S/A
1801 Fenil-Vevey
SWITZERLAND



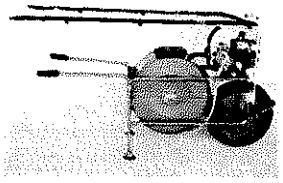
WHEELBARROW POWER SPRAYERS

MP60 This has a 60 litre tank. It has a balloon tyre. Weight: 36kg.

HOLDER GmbH & Co.
Stuttgarter Straße 40-45, P.O. 1555
7340 Metzingen, W. GERMANY

FAMOS 61 Single wheel barrow sprayer with sturdy steel frame and 60 litre polythene container. Large filling hole with strainer and screw cap. Suction strainer in container outlet. 400 × 100 wheel on ball bearings. Low centre of gravity. Removable transit handles. K25 with Briggs and Stratton motor. 4-stroke engine, pump delivery 1/min 25. Pressure: 30 bar. Length: 135cm. Width: 40cm. Height: 67cm. Weight: 50kg.

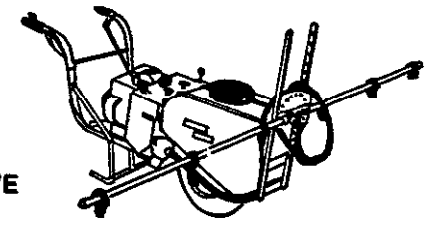
CARL PLATZ GmbH
Postfach 466, Wormser Straße 119
6710 Frankenthal/Pfalz
W. GERMANY



CAR METAL 70

Barrow mounted sprayer, with plastic coated steel tank and spray boom, capacity 70 litre.

F.lli GIACOMO & LUIGI CARPI
42028 Poviglio, Via Romana 82-R.E.
ITALY



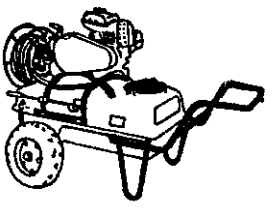
POWERDRIVE SPRAYERS

HORSTINE FARMERY POWERDRIVE SPRAYER. Self propelled, forward and reverse. 3 metre spray width. Capacity: 50 litres (100l version available). Pressure: 6 Bar. Speed: 5kg/h. Jets: 6 × F.110 Fanjets. Pump: 31.5 litre/min. Weight: 78kg. Delivery rate: 114-1210 litre/ha (above).

HORSTINE FARMERY LTD.
North Newbald
Yorkshire YO4 3SP, U.K.

RAPID MK 5 A portable sprayer designed for the horticulturalist. Incorporating a diaphragm pump and a 4-stroke engine. The Rapid Mk. 5 can handle a wide range of chemicals including wettable powders. Tank: 54 litre — plastic. Boom: 2.7 metre spraying width.

E. ALLMAN AND CO. LTD.
Birdham Road, Chichester
Sussex PO20 6BT, U.K.



TWO-WHEELED SPRAYERS

Below are 4 companies who supply different types of two-wheeled sprayer, with the motor mounted on top of the chemical tank.

MPS — 150 F This sprayer (illustrated above) has a 150 litre fibre reinforced plastic tank. It weighs around 100kg. Working pressure up to 35kg/cm².

HATSUTA INDUSTRIAL CO. LTD.
4-39 1-chome, Chifune
Nishiyodogawa-ku, Osaka
JAPAN

CHAPIN POWER SPRAYER This sprayer has a capacity of 57 litres. It is powered by a 3hp engine.

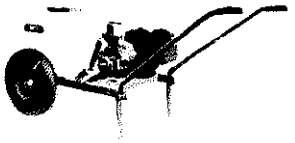
HOCKMAN-LEWIS LTD.
200 Executive Drive
West Orange, NJ 07052, U.S.A.

BIRCHMEIER A-150 WHEELBARROW SPRAYER This sprayer has a 150 litre tank. It is powered by a 5hp engine and has a 5m delivery hose. Weight: 95kg.

BIRCHMEIER & CO. LTD.
CH 5444 Künten
SWITZERLAND

SPRAYCAT POWER SPRAYERS Two lines of sprayer are available with outputs up to 12 litre/min. Capacity: about 200 litres. The larger models can have outputs up to 40 litre/min.

ROOT-LOWELL CORPORATION
Lowell, Michigan 49331, U.S.A.



WHEELBARROW SPRAYERS

Below are several manufacturers of various-wheel wheelbarrows sprayers.

FAMOS 121 A two-wheeled barrow sprayer (photo above) with 100 litre polythene container. It has a large filling hole and strainer. 400 × 100 pneumatic tyres. Pump delivery: 25 l/min at 30 bar pressure. Weight: around 70kg.

CARL PLATZ GmbH
POB 466, Wormser Straße 119
6710 Frankenthal/Pfalz
W. GERMANY

ARABIAN BIRD MODEL WH-1K This sprayer has a 120 litre chemical tank and two high pressure spray bars. Pressure is 20kg/cm² and delivery is up to 8.8 litre/min. Powered by 4-stroke air-cooled engine.

MARUNAKA SPRAYER & DUSTER MFG. CO. LTD.
11 Makaida Nishimachi, Kieshoin
Minamiku, Kyoto
JAPAN

TS 100 This has a capacity of 100 litres. The screw-on lid is 24cm wide. Weight: 71-75kg. Optional equipment includes hand guns and an all-purpose folding 3m 6 nozzle spray boom.

TECNOMA
54 rue Marcel Paul
B.P. 195, 51206 Epernay
FRANCE

CD 100 & CD 120 These sprayers have 100 litre polythene tanks and are available with three different types of pump and a 3 or 5hp motor.

R. & F. BERTANI
Via Leonardo da Vinci, N. 41
20081 Abbiategrasso, Milano
ITALY

HARDI POWER SPRAYER BS 2 & BS 4 These 2 and 4 hp sprayers have capacity of 100 litres and 120 litres respectively. Pump output is 20 litre/min and 45 litre/min respectively. A spray lance of 4 nozzles with 5m of hose is supplied.

HARTVIG JENSEN & CO. A/S
6 Farverland, DK-2600 Glostrup
DENMARK

MICROVERT SPRAY BARROWS 21880 & 21900 These two models deliver spray at the rate of 20 litre/min and 30 litre/min respectively. It is powered by an air-cooled 3hp motor.

R.C.M.
32 Cours de Verdun, 38200 Vienne
FRANCE

TWO-WHEELED POWER SPRAYERS

The 8 companies listed below have all indicated that they can provide various types of two-wheeled sprayer comprising a cylindrical container of about 100 litre capacity and a rear mounted 5hp (or thereabouts) petrol engine.

MODEL MP 11-10 & MP 11-9 The tank of the first of these models is made from brass, the second is made from polyester. Output is 34 litre/min at up to 40 bar. (Illustrated right).

HOLDER GmbH & CO.
Stuttgarter Straße 40-46
P.O. 1555
7430 Metzingen
W. GERMANY

M-100 S This sprayer designed for work in tree crops has a 100 litre tank. Spraying distance 7m vertical and 9m horizontal.

MORAVA
Servisna Sluzba, 1200 Požarevac
Djure Djakovića BB
YUGOSLAVIA

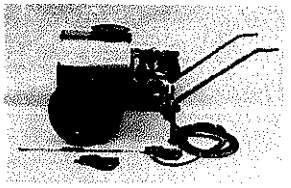
C2 YIL DIRIM & C3 SIMSEK MOBILE POWER SPRAYING UNITS These sprayers have a capacity of 100 and 50 litres respectively. Spraying distance up to 10m at 1m width. Weight: about 80kg.

MAKINA VE KIMYA ENDÜSTRISI KURUMU
Tandoğan Mevdani, Ankara
TURKEY

MOTOR 220 & MOTOR 100 These sprayers can have capacities of 100 to 200 litres.

BLANCHARD & CIE
Chémeré, 44680 Ste. Pazanne
FRANCE

ASPEE HTP POWER SPRAYER This is usually provided mounted on a 2-wheeled trolley (PS13). A variety of spray lances can also be obtained.



AMERICAN SPRING & PRESSING WORKS PVT. LTD.
P.O. Box 7602
Adarsh Housing Society Road
Malad, Bombay 400 064
INDIA

DOUVEN SPRAYERS Three larger types of models are available with tank capacities from 100 litres upwards to 1,000 litres. Four types of pump are available.

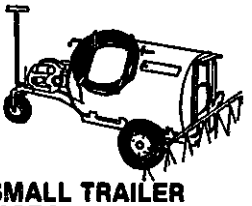
DOUVEN
Energiestraat 16, 5961 PT Horst
P.O. Box 6006 AA Horst
NETHERLANDS

FAMOS 122 Output 34 litres/min. Motor-driven trolley sprayer 100 litres. Of robust steel tube frame construction with liquid tank in solid brass. Large filling opening with V2A steel sieve and cover. Outlet device. Hydraulic agitator. Wheels with roller bearings and pneumatic tyres 3.5 × 12. Adjustable and detachable driving rods. Pump: power pump K 30 C, 34 litres/min, 0-40 bars. Length: 161cm. Width: 72cm. Height: 80cm. Track width: 62cm, ground clearance: 22cm. Weight: 77kg.

CARL PLATZ GmbH
POB 466, Wormser Straße 119
6710 Frankenthal/Pfalz
W. GERMANY

M7 & M10 WHEELBARROW SPRAYERS These have 4hp and 5hp engines respectively.

NIR-DAVID METAL WORKS
Mobile Post Gilboa 19150
ISRAEL



SMALL TRAILER MOTORIZED SPRAYERS

The companies listed below produce a wide range of small, three-wheel trailer sprayers which are hand pulled. Tank capacities range between 100 and 300 litres. Optionally can be mounted behind small tractors as a two wheel trailer; the pedestrian handle and land wheel can be removed.

MINI TRAILER MOTORIZED SPRAYER These sprayers (illustrated above) are supplied with either 90 or 180 litre tanks. Maximum pressure 20 bar.

COOPER PEGLER & CO. LTD.
Burgess Hill, Sussex RH15 9LA
U.K.

THREE WHEEL SPRAYER X This sprayer has a 200 litre tank and three wheels, a diaphragm pump and a 4-stroke 2hp engine. A 4m spray-width boom can be fitted to this sprayer.

EVERS & WALL LTD.
Lambourn Woodlands
Newbury, Berks. RG16 7RX
U.K.

Other manufacturers are:

K.W.H. WHIRLWIND HOLLAND B.V.
P.O. Box 47, 4000 AA Tiel
NETHERLANDS

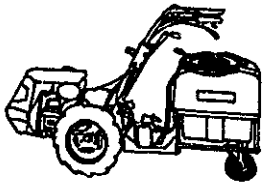
R. & F. BERTANI
Via Leonardo da Vinci, N. 41
20081 Abbiategrasso, Milano
ITALY

FISCHER S/A
1801 Fenil-Vevey
SWITZERLAND

TROLLEY-MOUNTED UNIT

This incorporates the Midget spraying unit with engine or single-phase electric drive, and a 250 litre plastic tank mounted on a 4-wheel trolley. The return hose is connected to an agitator pipe in the tank to ensure the chemical is kept mixed.

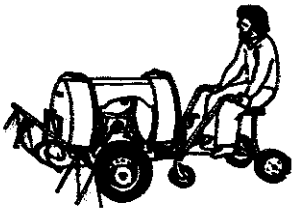
E. ALLMAN & CO. LTD.
Birdham Road, Chichester
Sussex PO20 7BT
U.K.



CARRELLO MTC. 100 Lt.

Two-wheel trolley with 100 litre polyethylene tank, pump flanged to P.T.O. which comes complete with suction and return hoses. Unit suitable for spraying by lances. Weight: 45-50kg. Two larger models also available.

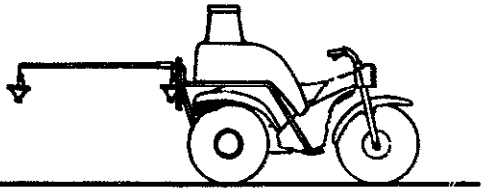
R. & F. BERTANI
Via Leonardo da Vinci, N. 41
20081 Abbiategrasso, Milano
ITALY



SPRAYMOBILE 25

A self-propelled sprayer with optional trailer seat for operator. 3 speed gear box with gear and clutch controls at rear of sprayer; fan-jet nozzles mounted on 3.25m wide boom; all sprayer controls mounted at rear of machine.

WILLCOX GROUP
Kings Road, Tyseley
Birmingham B11 2AN
U.K.



2AGT SPRAY TRIKE KITSET

This set, which comprises a 3.65m wide spray boom, pump, tank and all fittings, can be mounted behind any of the 3 wheel farm trikes that are currently available (Kawasaki, Honda, Yamaha etc). The spray boom has 3 Micron Micromax controlled droplet application atomizers mounted on it at a height of about 600mm from the ground. At this height the coverage is about 5.5m. The boom can be folded to 1.4m for transport. The CDA atomizers are driven by 12 volt 3 speed motors which spin the spray discs at 2000, 3500 or 5500rpm at which speeds droplets of 250, 150 or 70 microns are produced. This enables the sprayer to be used for herbicide, fungicide or insecticide application. The diaphragm pump can also be used for pumping chemical to a handgun. It has a 63 litre polythene tank. Weight of empty Kitset is 45kg.

C-DAX SPRAYERS
P.O. Box 1010
Palmerston North
NEW ZEALAND

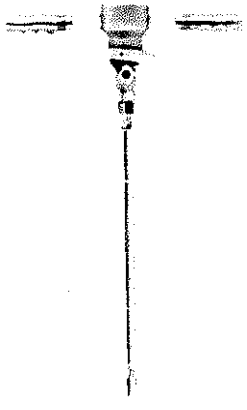
TILDENET NETTING

Netting can be used to protect high value crops from wind, sun and vermin and shade livestock in harsh climates. The netting manufactured by Tildenet is woven from UV resistant polythene. It can be used in a windbreak to control air flows into sheds by placing the netting along the sides and to control soil erosion by being pegged out on the ground allowing natural growth which, once established, will help secure the soil. By controlling light and airflow, evaporation can be reduced by up to 60%

TILDENET LS Tildenet Lockstitch is woven from block polythene, lock stitched to prevent fraying when cut. Available in 7 shade densities.

TILDENET EC Tildenet Economy is also available.

TILDEN INDUSTRIES (U.K.) LTD.
Brigate House
Stanley Street South
Bedminster, Bristol BS3 3PG, U.K.



VERSATOOL

This versatile injector (illustrated right) is available in two sizes 12mm and 18mm (Jumbo). It is, in effect, 3 tools in one for controlling termites:

- A slab treater
- A wood and void treater
- A soil treater — available with a lateral dispersion tip.

B & G EQUIPMENT CO.
P.O. Box 130, Applebutter Road
Plumsteadville
Pennsylvania 18949-0130
U.S.A.

H4-4B SOIL INJECTOR

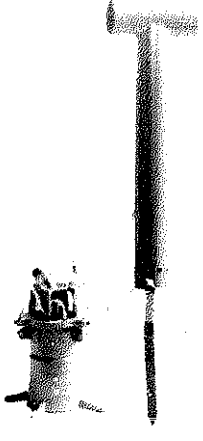
This injector (illustrated left) has a translucent 3 litre polythene chemical tank from which precise amounts (1-6cc) of chemical can be dispensed by depressing the micro-volume control knob on the top. Injection depth can also be controlled at 12, 15, 18, 21cm. Weight: 2.5kg.

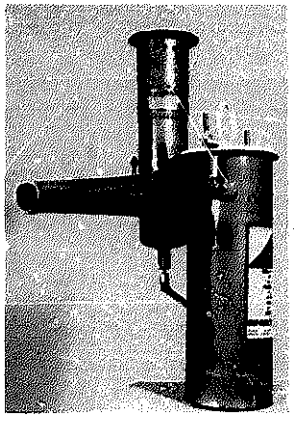
KIORITZ CORPORATION
5-1 Shimorenjaku, 7-chome
Mitaka, Tokyo 181
JAPAN

HINDSONS SEED TREATER

This electrically-driven machine comprises a feed hopper and mixing chamber with a regulated feed for the chemical insecticide or fungicide solution, which is stored in a 120 litre steel tank. Height 1030mm above a 1060mm stand. Weight of seed treater 120kg.

HINDSONS PVT LTD.
The Lower Mall, Patiala 147 001
Punjab
INDIA





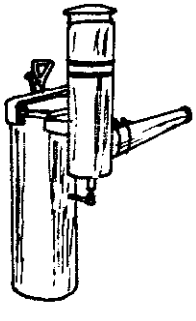
CARBIDE BIRD SCARERS

Calcium carbide and water produce acetylene in the main body of the equipment, which is compressed and ignited to produce an explosion. Half a kilogramme of carbide is sufficient for up to 12 hours operation. The Cecoco model (above) uses a piezo-electric ignition system. The Crop Protections model is illustrated above right and the Kumaon Nursery model is illustrated on the right, and both are lit by a pilot flame.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

CROP PROTECTIONS
522 Milan Industrial Estate
Abhyudenagar, PB 7833
Bombay 400 033
INDIA

KUMAON NURSERY
Ramnagar 244 715
Nainital, U.P.
INDIA



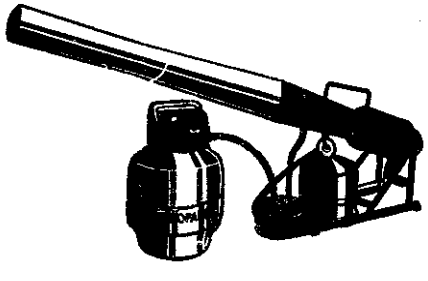
BATCH SEED DRESSER

For the coating of seeds with insecticide and fungicide, thus protecting them and allowing improved germination.

This model comprises a drum with offset crank. The drum is filled and emptied through a tightly fitting hatchway.

Specifications:
Power source: hand-operated.
Material: all metal.
Batch size: 15-25kg, depending on type of seeds.
Output: 100-150kg/h.
Manufactured by Laboulaye, Argentina and Grube, W. Germany and available through:

TECHNICAL ASSISTANCE (INTERNATIONAL)
P.O. Box 1224
Vosskuhlenweg 2
2072 Bargteheide
W. GERMANY

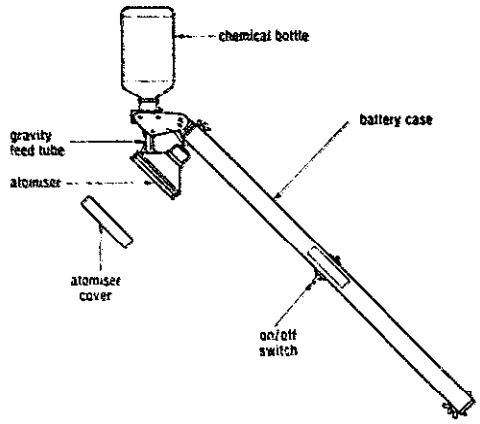


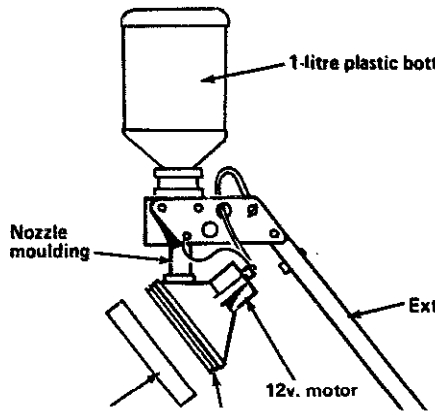
EXID THUNDERBIRD BIRD SCARER MARK VI

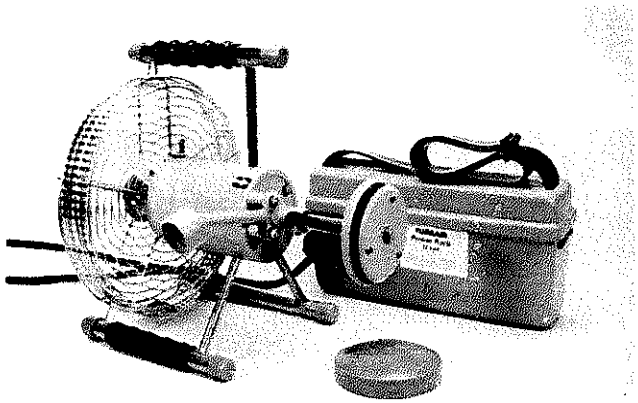
This bird scarer operates from a propane gas cylinder. As an optional extra there is an automatic high pressure clock timer on and off. Day and night fourteen day cycle without winding.

This model can be converted for use with a calcium carbide acetylene gas generator.

DRIVALL LTD.
Churchbridge Works
Cannock, Staffs, SW11 3JP
U.K.







TURBAIR SPRITE & FOX

Small 12 volt electric fan assisted hand held ULV Sprayer. Spraying time up to 60 minutes from fully charged battery. Range: 4.5-6.5m. Swath: 1.8-3.7m. Spray output: 1ml/sec. Container capacity: 1 litre. Coverage: up to 1.3ha/h. Weight: 8kg (including battery). Illustrated top left.

Also available Turbair Fox which is petrol engined version of the Sprite. Illustrated bottom left, Note: when in use some facial protection should also be used for certain agrochemicals.

TURBAIR LTD.
Britannica House, Waltham Cross
Hertfordshire EN8 7DR
U.K.

ULTRA LOW VOLUME CDA SPRAYERS

The manufacturers listed below produce similar types of ULV-CDA sprayer with an 8 battery power source in the handle. Droplet size about 70 microns.

MICRON ULVA 8 This has a 1 litre bottle for the chemical and four different sizes of nozzle mouldings for different flow rates. (Illustration above right).

MICRON ULVA 16 This has no extension tube and is a simpler cheaper design. (Illustration above left).

MICRON SRAYERS LTD.
Three Mills, Bromyard
Herefordshire HR7 4HU
U.K.

TIPON ULV SPRAYER This has a four position metering disc to control chemical flows. Working capacity up to 5ha/day. Weight: 1.6kg.

NIR-DAVID METAL WORKS
Mobile Post Gilboa 19150, ISRAEL

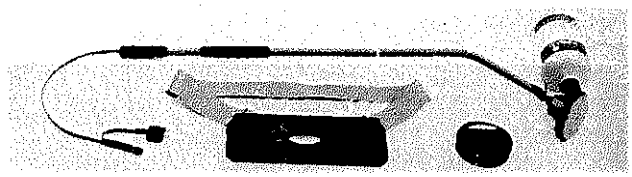
TECHNOHAC AGRICULTURAL MACHINERY IMPLEMENTS LTD.
New Industry Region
Petakh-Tikva, P.O.B. 225
ISRAEL

GIRO 1 This long model (1.4m in working position, 0.82m in transport position) is similar to the above models. Disc speed: 6000rpm when under load. Capacity: 1 litre. Weight with batteries: 1.8kg.

TECNOMA
54 rue Marcel Paul, B.P. 185
51206 Epernay
FRANCE

C8 INSECTICIDE — FUNGICIDE APPLICATOR This model has two nozzles to give outputs of 2 to 4 litres/ha. Coverage can be calculated from knowledge of swath width, walking speed and chemical output.

ETS. P. BERTHOUD
69220 Belleville-sur-Saône
Rhone
FRANCE



CONTROLLED DROPLET APPLICATOR SPRAYERS

The manufacturers listed below all produce similar CDA sprayers which are designed for applying insecticides and fungicides. The undiluted chemical is in a container mounted above the spinning-disc head of the sprayer. This is held in the air and the narrow spectrum 70 micron spray drifts with the wind across about 5-10m. One hectare can be covered within half an hour, in the right conditions. Chemical spray can be stopped by either turning off or disconnecting the external 12 volt power source or inverting the applicator so that the container is below the spinning-disc head. The Turbair X-J is illustrated.

AMERICAN SPRING & PRESSING WORKS PVT. LTD.
P.O. Box 7602
Adarsh Housing Society Road
Malad, Bombay 400 064
INDIA

SIGMA STEEL INDUSTRIES (REGD.)
A-2 Industrial Estate
Ludhiana 141 003, Punjab
INDIA

TAURUS SPRAYING SYSTEMS (PVT.) LTD.
20 Harrow Road, Msasa, Harare
P.O. Box AY 18, Amby
ZIMBABWE

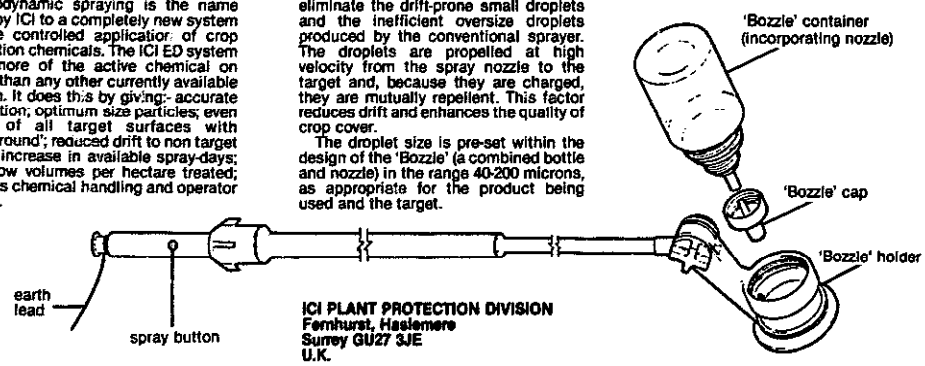
TURBAIR LTD.
Britannica House, Waltham Cross
Hertfordshire EN8 7DR
U.K.

THE ELECTRODYN HAND-HELD SPRAYER

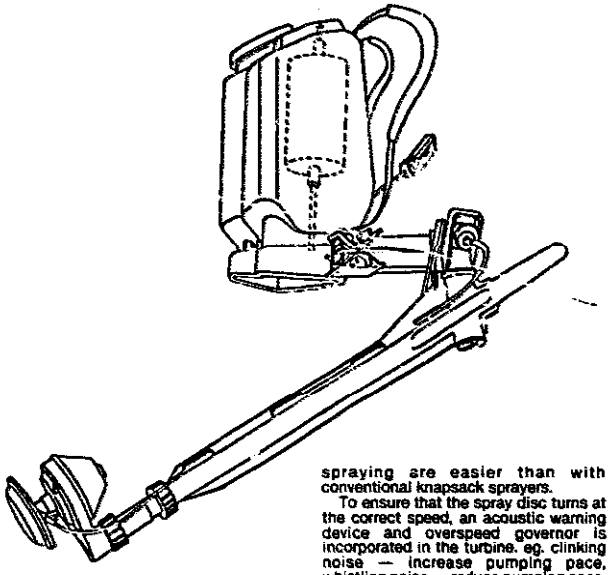
Electrodynamic spraying is the name given by ICI to a completely new system for the controlled application of crop protection chemicals. The ICI ED system puts more of the active chemical on target than any other currently available system. It does this by giving:- accurate deposition; optimum size particles; even cover of all target surfaces with 'wraparound'; reduced drift to non target areas; increase in available spray-days; uses low volumes per hectare treated; reduces chemical handling and operator hazard.

The 'Electrodyn' sprayer produces electrically charged droplets of a controlled size within a narrow spectrum. It has been designed to eliminate the drift-prone small droplets and the inefficient oversize droplets produced by the conventional sprayer. The droplets are propelled at high velocity from the spray nozzle to the target and, because they are charged, they are mutually repellent. This factor reduces drift and enhances the quality of crop cover.

The droplet size is pre-set within the design of the 'Bozzle' (a combined bottle and nozzle) in the range 40-200 microns, as appropriate for the product being used and the target.



ICI PLANT PROTECTION DIVISION
Fernhurst, Haslemere
Surrey GU27 3JE
U.K.



THE BIRKY KNAPSACK SPRAYER

The Birky sprayer is the first knapsack sprayer for the application of herbicides, using the principle of a pneumatically-driven spinning disc. It is a big step forward from the traditional knapsack sprayer and from the battery operated 'Handy' and 'Herby' LV sprayers and is of particular interest wherever supply of water is a problem, high working output is required, or where the use of tractor mounted equipment is excluded for one reason or another. The spinning disc is driven by air, supplied to a turbine by a pneumatic pump — no batteries are required. Thus maintenance and spraying are easier than with conventional knapsack sprayers.

To ensure that the spray disc turns at the correct speed, an acoustic warning device and overspeed governor is incorporated in the turbine. eg. clinking noise — increase pumping pace, whistling noise — reduce pumping pace.

Tank capacity: 5 litres (enough to treat ¼ha at 20 litres/ha. Swath width: 1.6m. Straps: two fully adjustable shoulder straps. Spray tube: plastic, adjustable in length. Spray Head: turbine housing; turbine; spray disc and flow rate control nozzle made of strong plastic; adjustable in height. Optimal revolutions of disc: 1200-1600rpm noticeable to operator by means of clinking and whistling noise. Approx. range of droplet size: 250-300 microns. Flow rates: two control nozzles are supplied for two different flow rates, maintaining a working swath of 1.60m. Yellow nozzle — 20 litres/ha. Red nozzle — 30 litres/ha.

BIRCHMEIER & CO. LTD.
CH 5444 Künten
SWITZERLAND

TURBAIR WEEDER

This low speed ULV sprayer generates large droplets of concentrated herbicide of uniform size.
Specifications:
Type: 6 volt battery electric, hand-held, controlled droplet applicator (CDA) for herbicides. Power source: miniature 6 volt DC electric motor supplied by 8 × 1.5 high power 'D' size dry cells (flashlight or transistor type) which give 60-90 hours spraying. Motor speed: 2000rpm (approx). Weight: without batteries 1.6kg; with batteries 2.3kg. Dimensions: handle folded 98 × 10 × 31cm; handle extended 182 × 10 × 31cm. (L × W × H). Swath: 0.9 — 1.3m (depending on chemicals). Spray output: 0.8-5.0ml/sec (depending on jet size). Spray container: 1 litre. Rate of working: 0.3-0.5ha/hour.

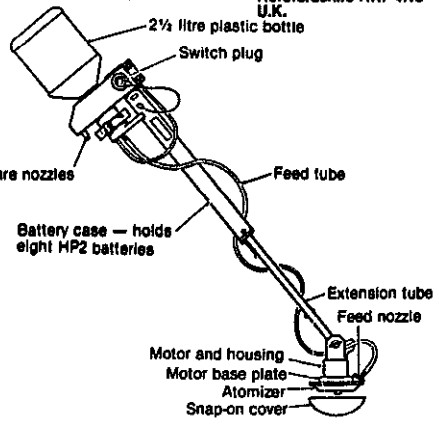
TURBAIR LTD.
Britannica House, Waltham Cross
Hertfordshire EN8 7DR
U.K.

MICRON HERBI 77

The Herbi is a lightweight, hand-held sprayer, and its job is to apply herbicides in an accurate pattern of droplets of closely controlled size. The precision of the Herbi is designed into the machine, and the efficiency of the spraying operation depends only on the skill of the operator. Consequently the user should make a careful study of the information in the booklet, and get to know the machine thoroughly. The Herbi produces droplets of controlled size for ultra-low-volume application of herbicide mixture so that they can be applied in a controlled swath of 1.2 metres. The droplets are controlled to a size of approx. 250 microns.

The Herbi has a 2½ litre bottle which contains the spray mixture, and this is fed to an atomizer by gravity; the atomizer is driven by a constant-speed motor powered by eight HP2 batteries. Nozzles of three sizes are supplied so that the standard flow-rate of about 1ml/sec can be achieved.

MICRON SPRAYERS LTD.
Three Mills, Bromyard
Herefordshire HR7 4HU
U.K.



TECHNOMA T5 CDA HERBICIDE APPLICATOR

This sprayer is similar in function to the Berthoud applicator illustrated below right, but the 4-battery case is located at the top end of the handle. This improves the balance of the implement.

The spray head is directional and a range of nozzles can be fitted for different flow rates. The spinning disc is powered by a 6 volt motor. There is a retractable disc protector. Application rates are 5-20 litres/h in a width of 1.2m. Average droplet size: 240 microns.

The 5 litre tank contains a calibrated air intake which ensures the gravity fed liquid is at a constant flow rate. The tank can be carried on the shoulder or in front. Weight, empty, without batteries: 1.7kg.

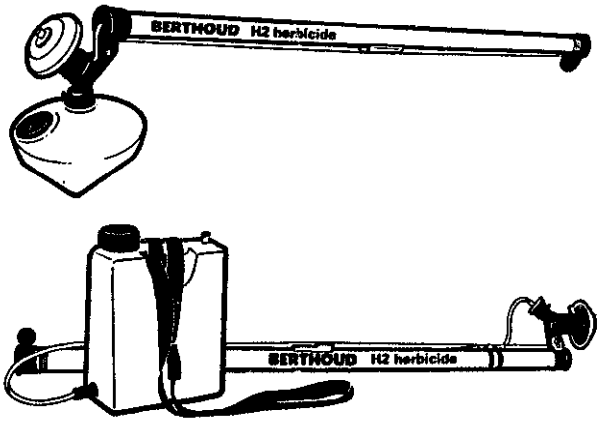
TECHNOMA
54 rue Marcel Paul, B.P. 195
51206 Epernay
FRANCE

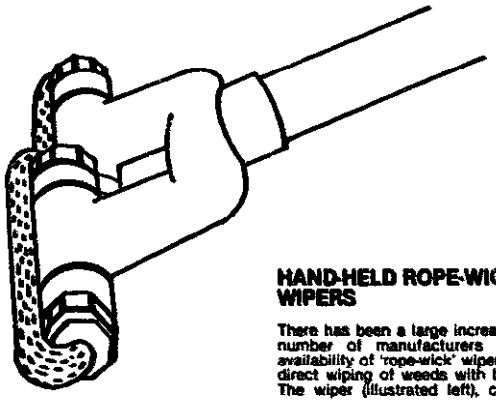
BERTHOUD H2 CDA HERBICIDE APPLICATOR

This spinning disc sprayer for the low volume application of herbicide is marketed in two forms. In one the 1.5 litre chemical tank is located immediately above the spinning disc head. In the other a 5 litre container is carried separately.

The 6 volt motor is supplied by 4 × 1.5 volt batteries contained in the handle. The angle of the head can be altered. When in use it should be kept 20-35cm off the ground which gives a spray width of 1-1.2m. Output of chemical is 1 to 1.5ml/sec depending on the nozzle used. At walking speeds of about 3km/h application rates are about 10 litres/ha (yellow nozzle) up to 20 litres/ha (red nozzle). By diluting the chemical as necessary, precise application rates of active ingredient can be achieved. Weight: empty, including batteries 1.5kg.

ETS. P. BERTHOUD
69220 Belleville-sur-Saône
Rhone
FRANCE





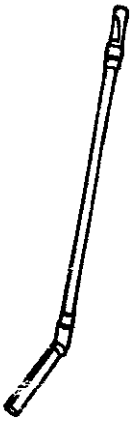
HAND-HELD ROPE-WICK WIPERS

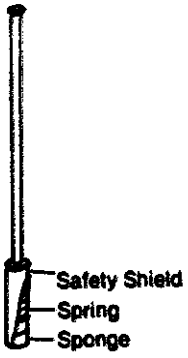
There has been a large increase in the number of manufacturers and the availability of 'rope-wick' wipers for the direct wiping of weeds with herbicide. The wiper (illustrated left), comprises two nylon braided ropes fed by a herbicide reservoir in the tubular handle. Note: the nuts can be tightened or slackened to control flow.

Other wiping devices include the 'hockey-stick' type (illustrated right), in which a piece of wettable carpeting material is supplied with herbicide from a small squeeze bottle, and the Croxptex roguing glove which has a pad wetted with herbicide, which is squeezed around weed plants. Hortichem produces both the Croptex roguing glove and a rope wick wiper. Hectaspan produce a wiper.

HORTICHEM LTD.
14 Edison Rd
Churchfields Industrial Estate
Salisbury
Wilts SP2 7NU, U.K.

HECTASPAN
62 London Street
Swaffham, Norfolk PE37 7DJ, U.K.





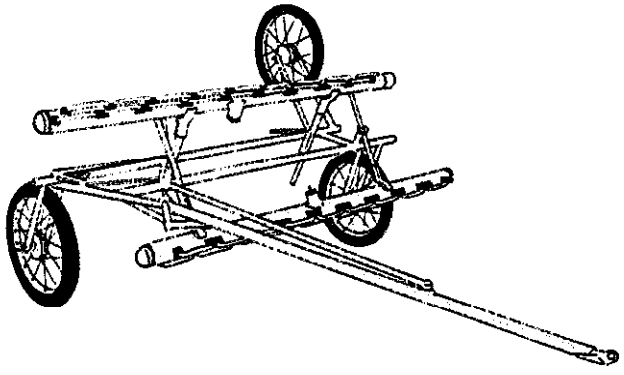
DABHAND SPOT WEEDER

This weeder comprises a retractable sponge head wetted by herbicide contained in the handle. To operate it the safety shield is placed over the weed and the spring loaded handle is depressed. A dab of herbicide (usually glyphosate) is automatically applied to the weed via the sponge-head. The operation takes about two seconds per weed plant.

The safety shield protects economic plants from accidental contact with the herbicide.

Length of weeder is about 80cm.
It is available from

TAVISLODGE LTD.
Middlefield Farm
Stapleford
Cambridge CB2 5AN
U.K.

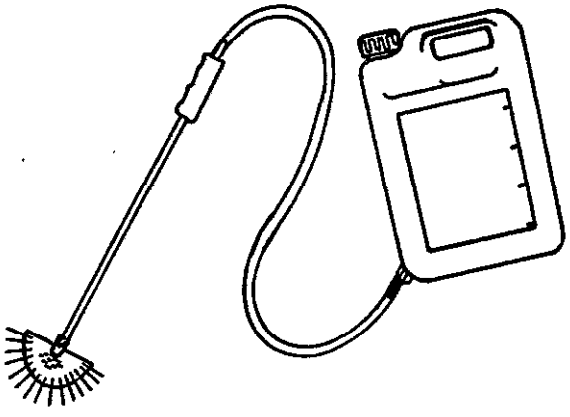


LIGA LIQUID GRANULE APPLICATOR

This is an innovative device for the application of chemicals. It applies large drops of chemical over a 1 metre swath when the flexible head is vibrated from side to side. Chemical is gravity fed to the head which is ribbed. Liquies of chemical are formed on the head and the vibrating action of the flexible head breaks these up into large drops.

The chemical can be contained in any plastic vessel with a screw top and fitted with an outflow pipe at its base. Approximately 700ml of chemical will cover 50 square metres if covering a swath of 1 metre and walking at about 6km/h.

LIGA CHEMICAL COMPANY
Deccan Farm
Ducks Cross
Wilden, Beds
U.K.

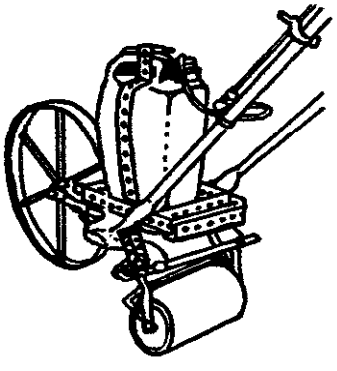


4 METRE FOLDING WICK BOOM TRAILER

The principle of this rope-wick applicator is similar to that described above. In this case, however, the trailer can be towed behind a farm motor trike. The two long two-metre tubes are fitted with chemical and the rope wicks transfer the chemical to the weed plants on contact. The height of the wick is adjustable from 10cm to 40cm.

The illustration above shows the second wick boom tube and supporting wheel folded up for transport purposes. In this position the trailer is only 2.2 metres wide.

TE PARI PRODUCTS
Beaconsfield Valley
No.9 R.D., Feilding
NEW ZEALAND



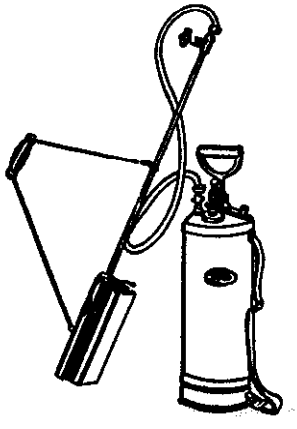
IITWAM-82 WEEDER

A newly designed and developed weeder-cum-herbicide applicator: IITWAM-82 has a 20 litre (5.3 gal) feed tank, a travelling wheel, applicating roller, soaking tube and wipers for all types of row crops under varying field conditions.

The machine has provision for adjusting row to row spacing varying from 15 to 100cm.

Unlike sprayers, there is no drift of herbicide and requires only about 60 litres of solution per hectare.

ALL INDIA CO-ORDINATED RESEARCH PROGRAMME ON WEED CONTROL
Department of Agricultural Engineering
Indian Institute of Technology
Kharagpur — 721 302
INDIA



FLAME THROWERS

Many manufacturers produce adaptations to standard sprayers which atomize a fuel such as paraffin, which when ignited produces a scorching flame. This can be used effectively to destroy weeds and diseased plants.

The Aspee Janata flame gun is illustrated left. Among many manufacturers there are:

AMERICAN SPRING AND PRESSING WORKS PVT. LTD.
P.O. Box 7802
Adarsh Housing Society Road, Malad
Bombay 400 064, INDIA

ENRIQUE F. ARRIGUTTI CETTA S.A.
Gregorio de Laferre 3210/2
1408 Capital Federal, ARGENTINA

HOCKMANN-LEWIS LTD
200 Executive Drive
West Orange
NJ 07052, U.S.A.

6. WATER LIFTING

JEREMY HARTLEY

Water is a primary requirement for securing basic food supplies through crop, livestock and forestry production systems. In addition, sufficient safe drinking water is essential for the well being of human beings. Its provision may be a simple or complicated matter depending on the circumstances of each situation. Sometimes it may be possible to collect rainfall or run-off and distribute it by gravity to the intended point of use. More often, however, water lifting will be necessary in order to move water from the source to where it is needed. Ever since the dawn of civilization people have raised water both for domestic and agricultural needs and some types of water lifting devices are known to have been in use for 2,000 years or more.

In its broadest sense, the term pump can be used to describe any device for raising water, whether a traditional method such as scoop or rope and bucket or the most modern high-speed rotodynamic machine. A great variety of pumping equipment has been built over the centuries to meet the requirements of specific situations. History shows that water pumping technology changes in response to developments in power supply. Slow-speed reciprocating piston pumps driven by water-wheels or beam engines were replaced by higher speed rotary pumps powered by turbine machinery. Centrifugal pumps which have reached a high level of development are now used extensively in industrialized countries, because suitable prime movers, such as high speed engines and electric motors, are widely available.

The basic need to pump water is the same in industrialized and non-industrialized countries. However, there are important differences in the requirements to be satisfied concerning manufacture, operation and maintenance, and above all the power available for pumping and the finance for meeting capital, running and replacement costs. This does not imply that there is

no place for modern, capital-intensive machinery in poor countries. There is a need, but it is generally limited to a few major urban water supply undertakings or large irrigation projects. The majority of those living in rural areas with limited resources, need affordable, convenient and reliable water supply systems which are economicaly, socially and technically appropriate to their particular circumstances — to improve domestic and personal hygiene and develop new possibilities for food production.

Water sources, water quality and pumping head

For large numbers of rural people, obtaining water for drinking, preparing food, washing and cleaning, watering their livestock and their crops means drawing it from traditional sources as their forefathers have done for centuries. The fortunate may be able to collect and store rainwater from the roofs of their homes, but scattered communities usually depend upon surface or shallow groundwater supplies. Ponds, lakes, rivers and streams are usually polluted, while rainwater, springs, wells and boreholes are of comparatively better quality and are therefore preferable to treating contaminated sources for drinking-water supply. Where springs exist it should be possible to supply potable water to parts of the community by simply protecting the source and installing a gravity-flow distribution system. Wells and boreholes, on the other hand, will inevitably mean pumping, which even from a shallow depth involves the use of energy.

Water for domestic use should be of high quality, and this necessitates protection of the source against pollution and has led to the much favoured technology of handpumps fitted to boreholes or sealed wells. An alternative strategy which avoids the need to displace traditional methods like the rope and bucket may be to introduce the kind of adaptation shown in Figure 1 (Blair bucket pump) together with a hygiene education programme for the users. Some suggested advantages of such a strategy include suitability for local manufacture, reduction of dependency on bought-in spare parts and the simplification of maintenance — a common problem encountered by many handpump projects. For irrigation or livestock purposes water quality considerations can be relaxed, although in the former case salinity problems should not be overlooked. Whenever possible physical, chemical and microbiological examination of the water source should be carried out in order to assess its suitability for the intended use.

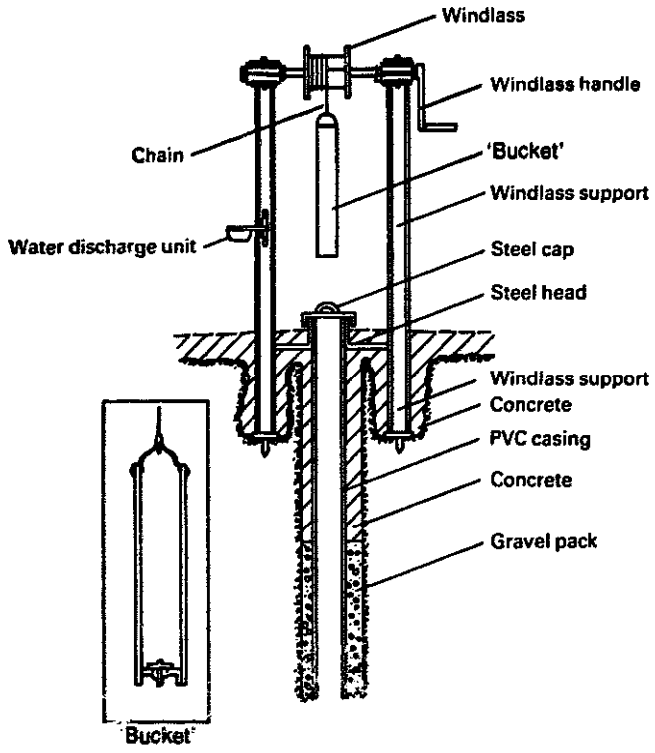


Fig.1 Blair bucket pump.

One of the most important points concerning the water source is whether the water level is within the practical limit or 'lift capability' of the pump. Most pumps which rely on suction for their operation cannot lift water higher than about 6 or 7m and the practical solution in this situation is to position the pump below ground so that it is closer to the water level or even submerged. Apart from the distinction between low and high lift (or shallow well and deep well) which determines where the pump should be mounted, it is also necessary to know the exact magnitude of the head in order to calculate the power required to pump the desired amount of water and to estimate the cost of doing so. It is the head during pumping which determines the power requirement. When water is pumped very slowly, the relevant head for power calculation is simply the difference in level between the outlet (typically the pump spout) and the water surface. At higher capacities, the head may increase because of friction caused by the water flowing through the pipework or because the water level is lowered. If the water level in a well falls significantly at the required pumping rate, even though the yield may be adequate, consideration should be given to the use of smaller pumps on two or more dispersed wells in order to ensure pumping through a lower head. In such cases, the power required and associated capital and running costs of using several smaller pumps — either in parallel to deliver the required quantity of water or in series to meet the required head — should be compared with the single pump option.

Power sources and water requirements

Energy for water lifting may be obtained directly from the sun, wind or water or indirectly from plants and fossil fuels converted into human, animal, engine or electrical power. The power available from these different sources, combined with the depth from which the water must be raised, imposes practical limitations on the quantity of water that can be raised in a given time and consequently has a major bearing on the choice of pump and prime mover combination for a particular purpose. For example, a handpump lifting water from 5 metres can provide approximately 2.5m^3/h under continuous manual operation; this means that to irrigate 0.25ha of 'boro' rice under Bangladesh conditions would require 8 hours pumping per day throughout the 100-day growing season. By contrast, a small engine or motor-driven pump of say 2.5kW could provide the water requirements in approximately five minutes. Figure 2 compares graphically the output power from different prime movers. It shows the magnitude of the difference between human muscle power at one end of the scale and engines at the other. A similar order of magnitude difference exists between the volume of water needed for

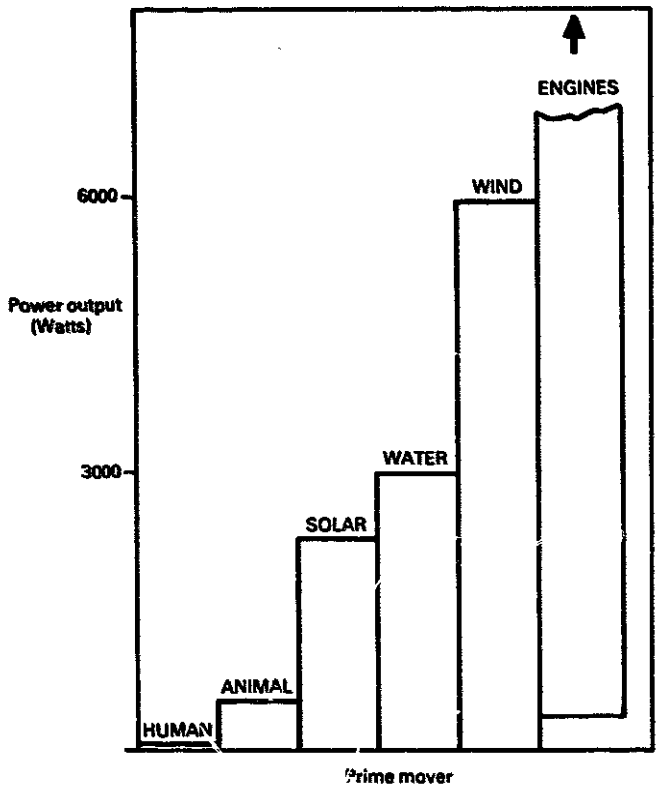


Fig.2 Available power output from various prime movers.

different purposes. If the water pumped in the previous example was available for domestic use instead of irrigation, it would be enough for a day's supply for a community of about 600 people, allowing 20 litres/person. Put another way, the daily irrigation requirement for 1ha of grain would satisfy the domestic water needs of several thousand people or a similar number of livestock. This illustrates the 'thirsty' nature of irrigation, which if it is dependent on pumps will be equally demanding on energy. Before deciding to invest in pumped irrigation it is therefore advisable to investigate carefully the viability of alternatives such as improved rain-fed systems or gravity-flow irrigation. Whichever technical solution is chosen it is essential to

Table 1. Approximate water requirements for various purposes.

Use	*Daily requirement*
Domestic	
minimum for survival	5 l/person
water carried home from distant communal supply	10 l/person
water carried home from nearby communal supply	30 l/person
one tap in each house	50 l/person
multiple tap connections	200 l/person
Livestock	
cattle	35 l/head
horses, mules and donkeys	20 l/head
sheep and goats	5 l/head
poultry	25 l/1[illegible]
pigs	15 l/he[illegible]
Irrigation	
including conveyance and field application losses	5 to 10mm or 50 to 1[illegible]m³/ha

consider the efficient management and economic use of water; evidence shows that the poor performance of many irrigation schemes stems from fundamental weaknesses in planning and management.

Human muscle power Reliable field data on human power for pumping is extremely scarce. The power available from muscle groups depends on the weight and strength of the individual, the duration of the task, and the environment. Table 2 presents some indicative data and shows that for most water-lifting tasks using existing devices the human power output is in the range of 30 to

Table 2: Human power output (Watts).

Muscle group(s) involved	*Sustained (up to 6 or 7 hrs per day) with short rests as and when required*	*10 to 15 mins*	*Few mins*
Mainly arms and shoulders	30W	60W	70W
All body (arms and shoulders, back and legs — non-pedalling	40 to 60W	70W	100W
Pedalling	75W	180W	300W

60W — the lower value for sustained irrigation pumping and the upper value as the maximum expected for short-duration domestic water pumping, excluding pedalling. Assuming an overall (mechanical) efficiency of 25 to 60% (the lower for some traditional devices, the upper for a

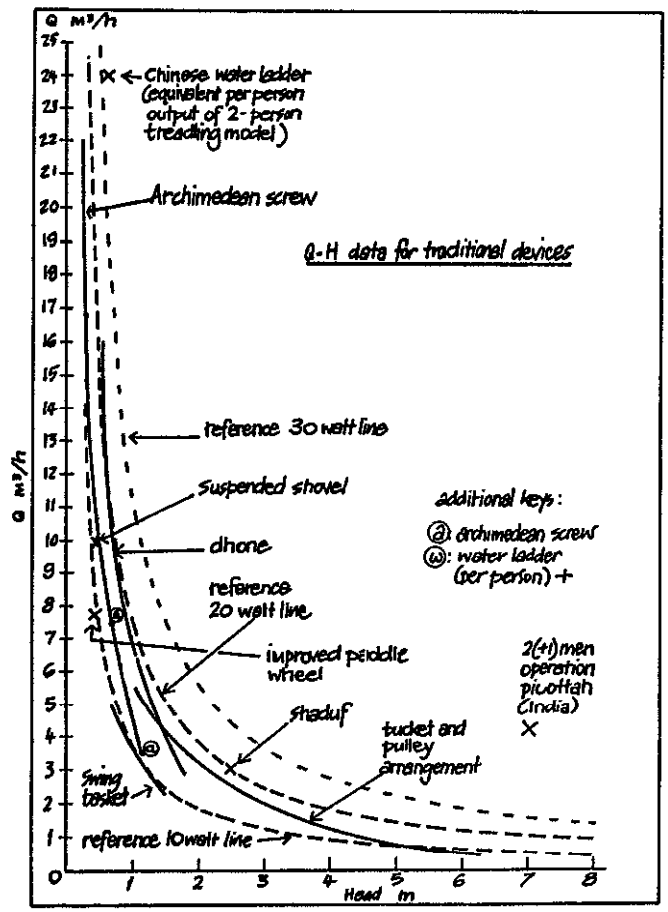


Fig.3 Discharge versus head performance: traditional human-powered pumps.

good handpump) then the output power of the water actually lifted is in the range of 7 to 35W. Figure 3 shows the discharge versus head performance data for various traditional human-powered pumps, together with the 10, 20 and 30W power curves; it is interesting to note that most of the devices fall well within the range predicted above.

Table 3. Animal power output (Watts).

Weight of animal kg	*Single animal W*	*Pair of animals W*
325	190	340
4[illegible]	235	425
5[illegible]	295	525

The use of human power for pumping is particularly significant in the conditions of subsistence-level rural communities, because human energy requirements can be provided from locally produced food, while fossil fuel costs continue to rise and electricity is not generally available. Also compared to other alternatives the capital and running costs of the equipment are low provided there is minimal opportunity cost for the labour. However, the low power availability limits its application to lifting small amounts of water from deep wells and boreholes for domestic use or proportionally larger amounts from shallow wells for irrigating small plots.

Animal power Draught animals of various types are a common and vital source of power in many countries of the Third World. The available power output depends on a number of factors including weight, strength, duration and nature of work (continuous, discontinuous, sustained or short-term), and the environment. Compared to human muscle power they are approximately 5 to 10 times more powerful. Table 3 gives an indication of the power available from different sized animals working alone or as a pair. An alternative rule-of-thumb guide is 60W per 100kg animal weight. Figure 4 shows the discharge versus head performance data for the most common traditional animal-powered pumps with the 100, 200 and 250W power curves superimposed.

Water power. Water power is derived from the energy contained in flowing or falling water. Its great attraction is that of usually being continuously available — although fluctuations will naturally occur with changes

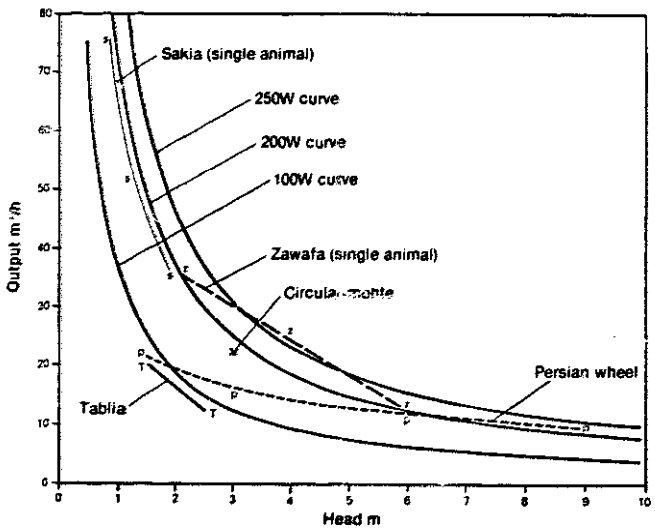


Fig 4. Discharge versus head performance: Traditional animal-powered pumps.

in river flow. Several types of water wheel and turbine are available for utilizing this power. The choice of device will depend on the available head of water, and technical and economic considerations at each particular site. Automatic hydraulic ram pumps, for example, are totally different from wheels and turbines; they are designed to exploit the phenomenon of water hammer to force a small proportion of the water flowing through the pump to a higher elevation.

Solar power Solar-powered water pumping systems are totally independent of any fossil fuel supply, but their output is intermittent, because the availability of solar energy during the day at a particular location is periodic in nature. Water pumping is one application of solar energy with great potential, since the complex problem of energy storage can be avoided by storing the pumped water. Most commercially available equipment converts solar radiation directly into electricity which powers an electric motor-driven pump.

Wind power As with solar power, the availability of wind energy at a particular site may vary considerably from day to day and with the seasons. Just as the economics of running an engine-driven pump will be closely tied to the cost of fuel, so the feasibility of wind pumps depends closely on the availability of wind energy. The energy in the wind is not directly proportional to its speed — in fact the output of a windmill varies with the cube of the windspeed. In other words, doubling the windspeed has the effect of increasing the available energy by a factor of eight ($2^3 = 8$), while a halving of the windspeed reduces the energy to one eighth. The energy availability being thus so much more variable than the windspeed means that it is generally not practicable to make use of winds with speeds lower than about 8 to 11km/h, while winds higher than about 50km/h tend to be too powerful to be used conveniently. It is important therefore that there are reasonably frequent winds available at a proposed windpump site in this range, preferably above 16km/h and certainly about 8km/h.

With greatly increased oil prices there is a considerable revival of interest in wind power both for water pumping and for electricity. The cattle- and sheep-raising industries of the arid central USA and central Australia still rely on water-pumping windmills in remote areas where fuel supplies or maintenance facilities are difficult to arrange for internal combustion engines. It has been estimated that as many as a million of these, mostly fitted to wells or boreholes, are in use around the world today. Windpumps are as yet not so widely used for irrigation, but notable examples from Crete and Peru demonstrate that under favourable conditions (low to medium lift) the use of many small locally manufactured machines can be a viable alternative to a single large windpump or other pumping system.

Diesel and petrol engines The internal combustion piston engine which, together with the electric motor, is by far the most common prime mover in the 5 to 500hp range, has developed in two main forms: the diesel (compression ignition) engine and the petrol (spark ignition) engine. The main reasons for the success of these engines is their convenient 'instant start' and 'independent run' capabilities, their compact size, their relatively high power-to-weight ratio and their cheapness. However, the internal combustion engine's main virtue is also its weakness, as in order to achieve easy combustion within the working cylinder it is necessary to use a clean and readily ignited fuel; they are therefore

Table 4: Water lifting devices and their application.

	Prime Mover[1]		Head Range				Application	
	Typical	Alternate	Very low[2]	Low[3]	Medium[4]	High[5]	Irrigation	Domestic
Traditional devices								
Water jar	H		●				●	
Water scoop	H		●				●	
Swing basket	H		●				●	
Dhone	H		●				●	
Paddle wheel	H		●				●	
Water ladder	H	AWiEM	●				●	
Archimedean screw	H	WiEM	●				●	
Shaduf	H		●	●			●	●
Picottah	H		●	●			●	
Rope & Bucket	H			●	●	●		●
Mohte	A			●			●	
Circular Mohte	A			●	●		●	
Persian wheel	A	EM		●			●	
Sakia/Zawafa	A	EM		●	●			●
Chain & washer pump	HA	EM		●	●		●	●
Water wheel	Wa		●					●
Factory-made pumps								
Shallow well handpump	H	AWiEMS		●			●[6]	●
Deep well handpump	H	AWiEMS		●	●	●	●[7]	●
Diaphragm pump	H	E	●	●			●[6]	●
Semi rotary pump	H		●	●				●
Centrifugal pump	EM	S	●	●	●	●	●	●
Hydraulic ram pump	Wa						●[8]	●

Notes:
1. Key: H = human; A = animal; Wi = wind; Wa = water; E = engine; M = electric motor; S = solar.
2. Surface water up to 2m.
3. Shallow open wells up to 7m.
4. Wells up to 20m.
5. Wells and boreholes over 20m.
6. Applicable to very low lifts and small areas.
7. Applicable when coupled to the more powerful prime movers.
8. Occasionally applicable for small plots in hilly areas.

invariably dependent on petroleum-based fuels which have become increasingly expensive and scarce in many parts of the world. In common with other complex machines they need regular maintenance to keep in satisfactory running order, and to achieve this a reliable supply of spare parts and lubricants will be essential, together with the relevant servicing skills.

When comparing different commercially available engines it soon becomes apparent that there is a tremendous variation in types available. Diesel engines tend to be heavier and are more robust in construction than petrol engines, which are more compact for their power output and are simpler and cheaper to manufacture. The diesel engine is also inherently more efficient and often has a longer life and better reliability than the petrol equivalent. The main virtue of petrol engines is where light weight is needed, to allow easy portability, or where low capital cost and simplicity are important. It is a mistake however, in many cases, to consider capital cost as a primary choice criterion because the actual running costs depend at least as much on factors such as total engine life, fuel and maintenance costs. It follows from this that it is better to run an engine at a lower power than its 'maximum rated power' in order to prolong its life. Another reason for 'derating' is that better fuel economies can be obtained. For applications requiring continuous reliable operation for long periods, a large, heavy, slow-running engine would be a good choice, while for intermittent applications or where portability is needed, a cheap, compact high-speed machine may be appropriate.

Electric motors These are available in a very wide range of sizes from a fraction of a hp to over 100hp. They are generally more reliable than diesel and petrol engines and are, therefore, often preferred as a source of power for water pumps where a reliable supply of electricity is available. The electric motor should be capable of carrying the full load to be imposed on it, taking into consideration the various adverse operating conditions under which the pumping equipment may have to work. If the power requirement of the pump exceeds the safe operating load of the electric motor, the motor may be damaged or may even burn out. In the selection of motors for use in pumping systems, direct-current (dc) permanent-magnet motors are generally favoured, as these offer good efficiency even when operating under part-load conditions. Mass-produced alternating-current (ac) motors are only half as efficient as their dc equivalents. Moreover, they require an inverter (to convert dc to ac) implying a further loss in efficiency. Thus, the overall efficiency of ac electric motors is low. Conventional electric motors have a segmented commutator and brushes. As wear takes place new brushes are required — typically at intervals of about 2,000 to 4,000 hours of operation. If the brushes are not renewed when they are worn out the machine can be seriously damaged.

Pumps for small-scale irrigation

These can be classified broadly into 'traditional' and 'factory-made' pumps. As the former are built by local

artisans or by farmers themselves they are not commercially available and so do not appear as entries in the catalogue pages of this section. However, they are mentioned in this introduction to give an idea of the different methods that are still in widespread use in some parts of the world today; in Bangladesh 40 per cent of the irrigated land is watered in this way.

Traditional water-lifting devices Each of the devices listed in Table 4 has developed as a long process of local innovation and adaptation to meet the water lifting requirements in a particular situation. Some have been developed to raise surface water from ponds, rivers or streams, while others are designed to reach deeper groundwater in wells. With the exception of the water-wheel they are all driven by human or animal muscle power which limits their application for irrigation to plots of about 0.25ha and lifts of a few metres for the human powered devices, and up to a few hectares and a maximum of about 20m for the animal-powered pumps. Whilst most of the simpler methods such as the swing basket cost very little they suffer from being very inefficient. The more efficient devices such as the *dhone* or *picottah* have a higher capital cost, a factor which seriously inhibits their widespread adoption among subsistence farmers. Although apparently crude by modern engineering standards, the devices are remarkably effective in the hands of their skilled operators. For lifts of a few metres these devices are particularly appropriate, possibly more so than a factory-made hand pump, since they all possess the important characteristic of being familiar and easily managed and maintained by their users. Some have the additional advantage of being portable, a highly desirable characteristic for the farmer whose total land holding consists of small fragmented plots.

In situations where this pattern of agriculture exists, the introduction of more powerful pumps will inevitably result in under-utilization and surplus capacity unless individuals can group together to share the equipment. Like other more powerful machines, the larger traditional devices are more costly, due mainly in this case to the bulk of materials required for their construction.

In between traditional water-lifting devices and factory-made pumps comes equipment developed locally for village manufacture or individual construction. The aim here is to develop designs which are compatible with the resources of the maker and user. The technology should be economically affordable, socially and culturally acceptable and technically maintainable, as well as creating paid work-places in rural areas. Examples of this level of technology which have successfully spread beyond the district of origin include the Rower and RDRS pumps which are described in the catalogue pages.

Factory-made pumps A huge variety of pump types and sizes are commercially available for a multitude of purposes. The entries in this section focus on small-scale water pumping alternatives arranged by type of prime mover (human, animal-power etc.), and within each category by increasing capacity and order of complexity. Their use and the conditions for which they are suitable are summarized in Table 4.

Handpumps tend to dominate the catalogue pages and this reflects the view of many agencies that they are an appropriate technology for rural water supply. Their particular advantage, like other renewable energy pumping systems, is that they are independent of fuel supplies. Compared with traditional devices they also have potential for supplying safer water since the well or borehole can be sealed from possible sources of contamination. Much attention has been given recently to handpump testing and selection, and to the idea of a handpump designed for Village Level Operation and Maintenance, 'VLOM'. Such attention has resulted in a number of new handpumps which incorporate features aimed at facilitating maintenance and repair at village level. The latter is a particularly acute problem with centralized handpump programmes where the annual cost of maintaining a pump can sometimes exceed its initial capital cost. Another aim of the 'VLOM' strategy is to develop local capacity to manufacture or part-manufacture pumps — thus reducing dependency on bought-in spares and building up local expertise in servicing the equipment.

One of the main disadvantages of manually-operated pumps is their limited output and where the head and the discharge required is too great it becomes necessary to consider more powerful alternatives. In broad terms animal-powered devices offer the possibility of 5 to 10 times more power. A similar increase again can be obtained from wind, water or solar power and the output from engine or motor-driven pump sets ranges from equalling that of animal-powered devices up to several hundred times more. In a guide of this kind it is not feasible to cover the full range of equipment; instead a few examples are included to give the reader an idea of the sort of equipment available at the lower end of the range. Most of these consist of a self-priming centrifugal pump coupled directly, or by belt drive, to the prime mover. They are generally regarded as high volume low-lift pumps and are commonly used for irrigating from surface-water sources or shallow wells.

Costs, benefits and impact of pumps

The cost of a pumping system consists of the initial capital cost of the equipment, the running costs (fuel or incremental fodder in the case of animal-powered pumps, lubricants, spares, operator etc.) and eventually the replacement cost. In addition to the costs attributable directly to the pump, other investments are sometimes needed. For example, storage may be desirable to capitalize on wind- or solar-pumped water during periods of low or zero demand; or engineering work may be needed to modify the water source for the installation of a particular kind of pump. Hydraulic ram installations are a case in point — where the site engineering work may cost several times the value of the pump itself.

When asking for the price of a pump it is important to know exactly what items are included — for example, in the case of a handpump does the quote include pump rods and rising main for fitting to the required depth? Table 5 provides a very rough comparison between some of the alternatives. Running costs will vary from one situation to another, being heavily dependent on local factors such as the price of fuel, whether the farmer already owns a draught animal, the value attached to labour and Government subsidies — which can often work in favour of particular technologies, as for example, electric motor-driven pumpsets in India.

An important point to consider in any pump programme is how the capital, running and replacement

Table 5. Indicative capital costs of various pump types[1]

	0 Cost ($) 10,000
Shallow well handpump	
Deep well handpump[2]	
Deep well handpump[3]	
Animal powered chain & washer pump	
Hydraulic ram pump[4]	
Solar pump[5]	
Lightweight windpump[6]	
Multi-bladed windpump[7]	
Engine-driven pumpset[8]	

Notes

1. These costs are very approximate and are for comparison purposes only.
2. Conventional reciprocating piston type with hand lever.
3. Geared flywheel-assisted type.
4. Imported machine.
5. 250 hydraulic watt system.
6. Locally-manufactured machine.
7. Imported machine.
8. 3kW diesel pumpset.

costs will be met. This is particularly so in the case of drinking water supply where the potential for increased productivity — and hence income — may at best be only indirect and it is quite possible that people will be unable to contribute to the costs.

Another point which should not be overlooked is the *overall* system efficiency. The benefits of a highly efficient pump can easily be lost through a wasteful distribution system or poor methods of irrigation. With regard to health and safety, there is always the danger from unguarded shafts and other moving parts — as is the case with other mechanically-driven equipment. In the case of electric motor-driven pumps there is the additional hazard which arises when water and electricity are present together.

One of the main benefits from pumps is the provision of greater quantities of water thus allowing timely irrigation which can make all the difference between harvest or crop failure. Compared with human- or animal-driven pumps, the use of more powerful engine- and motor-driven units enables the delivery of larger quantities of water from greater depths in shorter time, removing much of the drudgery of the traditional methods and making time available for other work. Pumps also offer the potential for accessing safer drinking water from sources which if left open could become polluted. However, it should be added that the possible health benefits from cleaner water will not usually be achieved unless attention is also given to other factors such as better nutrition, hygiene and public health.

Pumps may also create unforeseen problems. An obvious example is that of siting borehole pumps in pastoral areas which frequently leads to over-grazing. A further complication is that if the water supply is limited it will inevitably become a focus of competition and potential conflict among its users. Another serious problem experienced in some areas is the lowering of groundwater levels caused by over-pumping. Not only does this increase the pumping cost due to the greater lift but it can also threaten the very livelihood of those poorer farmers dependent on shallow wells. This highlights the need for policy planning and water resource management, including proper control of groundwater extraction and recharge to maintain satisfactory levels. A final point which should not be overlooked is that increasing the potential for irrigation and the consequent concentration on cash crop production may give women a greater physical burden in the form of their extra labour contribution to this crop, on top of their traditional responsibility for the care of subsistence crops for family consumption.

Depending on the location and purpose of the water supply system there will be other factors which will need consideration in addition to the type of pump. For example, if surface water is not available an open well or borehole may have to be constructed in order to reach groundwater. If a borehole is chosen, its narrow diameter will limit the choice of pump when compared with the options available through an open well, and in the event of a pump breakdown, there may be no alternative way of drawing the water until the pump is repaired. Or, in the case of a pumped irrigation scheme where either energy for pumping or water itself are limiting factors, it is particularly necessary to consider ways of both conveying and applying water as efficiently as possible.

Frequently, the full benefits of a new water supply are not achieved due to lack of attention to user need. For example, unless it is planned to distribute the water by pipeline, the problem of how the water will be transferred to the point of use is generally left to the consumer. Invariably this results in make-shift arrangements at the well head to facilitate operations such as filling containers and water carts, washing clothes or watering animals. Not only is this inconvenient but it results in water wastage and unhygienic conditions around the distribution point. Whether water is to be used for human consumption, livestock needs or irrigation purposes it is vital to consider what happens after the pump is installed — so that the full benefits from the investment can be achieved.

Ebbo Hofkes, P. Eng.
IRC, The Hague

References

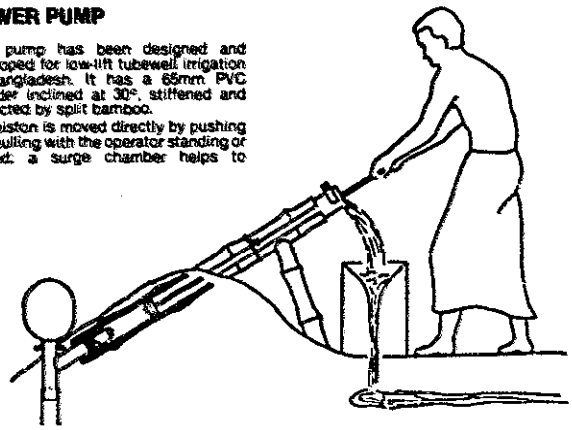
Hofkes, E.H., 1980 *Manual pumping of water for community water supply and small-scale irrigation.* The Hague: International Reference Centre for Community Water Supply and Sanitation.

Kennedy, W.K., Rogers, T, 1985. *Human and animal-powered water-lifting devices: A state-of-the-art survey.* London: Intermediate Technology Publications.

ROWER PUMP

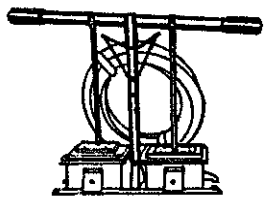
This pump has been designed and developed for low-lift tubewell irrigation in Bangladesh. It has a 65mm PVC cylinder inclined at 30°, stiffened and protected by split bamboo.

The piston is moved directly by pushing and pulling with the operator standing or seated; a surge chamber helps to improve operator comfort. Cheapness and ease of maintenance have been aimed for. The number of components have been reduced to a minimum and no special tools are needed for repairs. The piston and foot valve are easily removed by withdrawing them through the discharge opening. For protection the manufacturers recommend installing the pump partly buried in the ground so that only the discharge pipe is exposed. Suction lifts of up to 6m are possible but 2 to 4m is more typical. Output is in the order of 2 to 3m³/h, suitable for irrigating small plots. A household version is also available.



MIRPUR AGRICULTURAL WORKSHOP AND TRAINING SCHOOL (MAWTS)
Mirpur Section 12, Pallabi
Dhaka-16
BANGLADESH

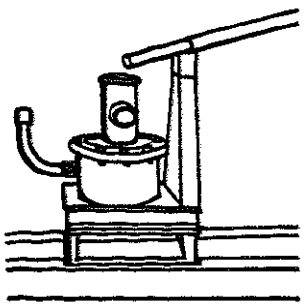
SWS FILTRATION LTD.
Hartburn, Morpeth
Northumberland NE61 4JB
U.K.



SARALA HAND-OPERATED PUMP SET

Portable pump operated by two people, suitable for pond, canal or well irrigation from depths up to 4.5m. Output 12m³/h at 2m suction head; 7m³/h at 3m.

WEST BENGAL AGRO-INDUSTRIES CORPORATION LTD.
23B, Netaji Subhas Road, 3rd Floor
Calcutta-700 001
INDIA



BUMI PUMP

Dunlop have especially developed the Bumi Pump to meet the irrigation needs of Zimbabwe's subsistence cultivators, and the varied requirements of the commercial farmer. This robust, versatile, hand-operated pump, illustrated left, has only three wearing parts.

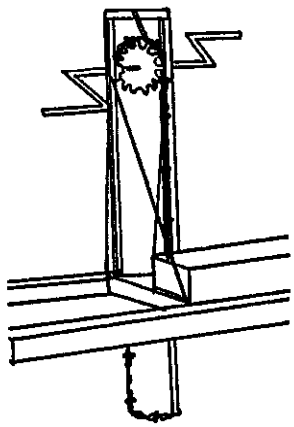
The pump is capable of irrigating over a hectare of land throughout the year. Typically, water is pumped either from a perennial water body, or a dry river bed (sand abstraction) into a canal for furrow irrigation. Although developed for irrigation, the pump has a variety of uses, ranging from dip tank maintenance to excavation de-watering. Capacity: 4 litres/stroke. Head: 10 metres (6m suction).

DUNLOP ZIMBABWE LTD.
P.O. Box 1200, Bulawayo
ZIMBABWE

RDRS TWIN CYLINDER TREADLE PUMP

The foot-operated irrigation pump illustrated above, has been designed and developed in Bangladesh with the emphasis on low cost and local manufacture. Two basic types are produced: the tubewell type, available in two sizes (120mm cylinder for lifts up to 3m and 90mm for higher lifts); and the portable low-lift type, available in three sizes (120mm, 150mm and 180mm) for pumping from ponds, canals, rivers or wells up to 3m. The pump cylinders are fabricated from mild steel and several components are interchangeable between the two basic pump types. The pulley is made from a local hardwood, the framework being constructed from bamboo in the field. The treadles can be worked simultaneously by more than one operator. Output 10m³/h at 3m; 4.5m³/h at 5m.

RANGPUR DINAJPUR REHABILITATION SERVICE
House 16, Road 16 (New)
Dhanmondi RA, Dhaka
BANGLADESH



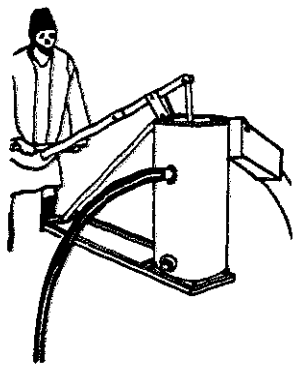
HAND CHAIN PUMP

This device, illustrated above, is capable of lifting water from a depth of 3 to 4 metres. Two people are required to operate it. The chain wheel is mounted on two heavy duty ball-bearings. The pipe is made of galvanized sheet and the rubber washers are easily replaceable. Pump weight 125kg. Capacity 18 to 20m³/h.

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

HAND-TURNING TUBE-CHAIN WATERWHEEL Similar to the above device, this model has a capacity of 8.6m³/h. Rotational speed 34rpm. Maximum lifting head 6m.

SHANXI HYDRAULIC MACHINERY
Quing Nian Road, Tai Yuan Shanxi
CHINA

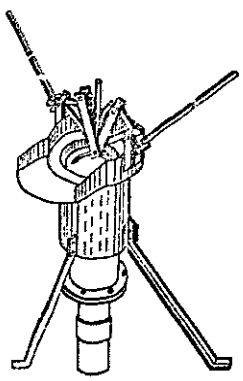


'MASTER' FADAMA PUMP

The 'Master' Fadama Pump illustrated left, is a simple hand-operated piston type lift pump capable of raising approximately 8m³/h at a 1m lift or 5.5m³/h at a 3m. It operates equally well in clear or dirty water. The pump is supplied with either a baseplate for fixing to a hard standing or a tubular frame for free standing. Complete with 4m of 60mm suction hose, the package weighs 52kg.

Another model, the 'Master' Mark 111 Pump is capable of raising approx. 10m³ at a 2m lift or 8m³ at 3 to 6m. A novel feature is a vacuum chamber incorporated into the wall of the pump which helps to eliminate surge and causes the water to flow smoothly. The pump is fully galvanized. Weight 82kg excluding hose.

L P ENGINEERING
Galloway Road
Bishop's Stortford, Herts
U.K.

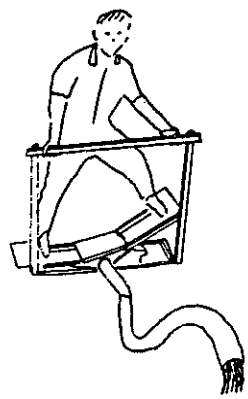


LOW-LIFT HAND PUMP

The pump illustrated left has been developed by the Agricultural Tools Research Centre at Bardoli. The 200mm diameter piston is operated by one or two people working the removeable handles. A compound lever mechanism increases the mechanical advantage, and piston guides regulate linear motion. All bushes are provided with oil holes for lubrication. The piston seals and flap valves are accessible for maintenance after dismantling the lever mechanism.

Suitable for ponds, streams or other surface water sources. If a vertical suction pipe is not possible, flexible hose can be used. Foot valve not required, but manufacturers advise priming cylinder before operating. One operator, 10 to 12m³/h at 2 to 2.5m head. Two people needed for max. lift 5.5m.

YANTRA VIDYALAYA
P.O. Box 4, Bardoli 394 601
INDIA



IRRI BELLOWS PUMP

This portable foot-operated pump was designed and developed by the International Rice Research Institute in the Philippines. It is made of two canvas bellows reinforced with metal inserts. The operator stands on two foot rests and alternately compresses and expands each bellows by shifting weight from one foot to the other to produce a continuous flow of water.

The device, which can manage both clear and muddy water, is suitable for pumping from irrigation ditches, open channels, river banks and shallow wells. Capacity 9m³/h at 0.5m head; 5.5m³/h at 1.5m. Weight 20kg.

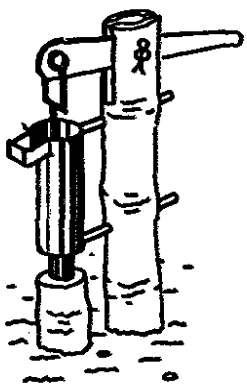
KALAYAAN ENGINEERING CO. INC.
4255 Emilia Street
P.O. Box 855 MCC, Makati, Rizal
PHILIPPINES

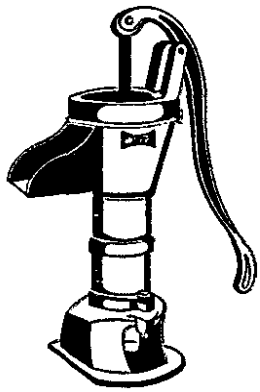
D.H. FARM IMPLEMENTS
Km 1 National Highway
Roxas City
PHILIPPINES

SHALLOW WELL DOMESTIC HANDPUMPS

RDRS HOUSEHOLD HANDPUMPS The inexpensive shallow well pump illustrated below is capable of lifting water from depths of up to 6m. Developed by the Rangpur Dinajpur Rehabilitation Service in Bangladesh, it is available in two sizes, the No.4 (80mm cylinder) and the No.6 (90mm) for very shallow wells. The pump stand, which incorporates the cylinder is made from mild steel and connects to a suction pipe and strainer of bamboo or commercial pipe. The pump is installed by fixing to a sturdy wooden post and fitting a wooden handle. Plans available from RDRS for interested constructors.

RANGPUR DINAJPUR REHABILITATION SERVICE
House 16, Road 16 (New)
Dhanmundi RA, Dhaka
BANGLADESH





OPEN SPOUT PITCHER PUMPS

CIECO MODEL SWP III This classical open spout handpump illustrated left can lift water from depths of up to 7m. The cylinder and piston are incorporated in the stand just below spout level. Priming is usually necessary to start pump discharge. Five sizes are available from 80 to 160mm cylinder diameter having capacities from 11 to 38 litres/min at 50 strokes.

CENTRAL INDIA ENGINEERING CO.
2153/5 Hill Street
Ranigunj, Secunderabad — 500 003, AP
INDIA

IRON PITCHER PUMP This cast iron model comes with a 80mm cylinder fitted to connect with a 32mm suction pipe. Suitable for cisterns or shallow wells up to 6m.

CUMBERLAND GENERAL STORE
Rt. 3 Box 479, Crossville
TN 38555
U.S.A.

PITCHER SPOUT LIFT PUMP This classical model has a 80mm cylinder and can be connected to either a 25mm or 32mm suction pipe.

LEE HOWL & CO. LTD.
Alexandra Road
Tipton, Staffs. DY4 8TA
U.K.

PITCHER SPOUT PUMP Four sizes available from 80 to 115mm with capacities from 25 to 45 litres/min. A closed spout model also available.

PUMPENFABRIK BEYER
Dorfstraße 25, Ot Wulfsfelde
2361 Pronstorf
W. GERMANY

'AMERICAN' TYPE NO. 264 Another classical design of pitcher spout lift pump. Closed spout versions available.

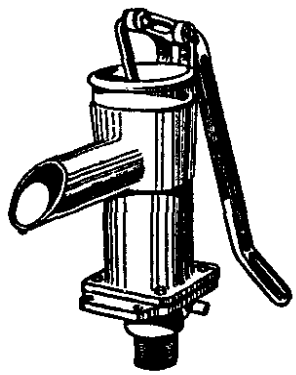
LANG FERRY & CIE
Brousseval (Mte-Marne)
52130 Wassy
FRANCE

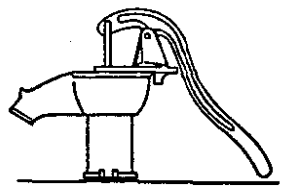
CLOSED SPOUT PITCHER PUMPS

*These handpumps have a closed, pipe-*like spout and enclosed base which help reduce splashing and improve sanitation. Apart from these features they are identical to the classical open spout variety being suited to cistern and shallow well pumping.

'POMPE A EAU' This model, illustrated right, is available in three sizes for shallow well pumping: 100mm diameter cylinder for depths up to 2m: 90mm for 2 to 4m; and 80mm for 4 to 6m. Respective capacities 100, 60 and 35 litres/min.

POMPES GRILLOT
Rue de l'Observance
B.P. 118, 84007 Avignon
FRANCE

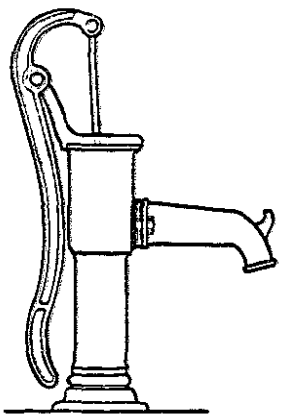


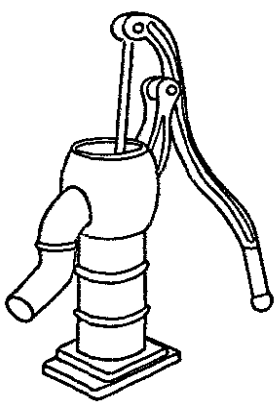


BRASS CYLINDER AND GREY CAST IRON PITCHER PUMPS Two models of these are available from the Cumberland General Store.

BAKER CISTERN PUMP A heavy cast-iron closed spout pitcher pump for ordinary shallow well applications.

CUMBERLAND GENERAL STORE
Rt. 3 Box 479, Crossville
TN 38555
U.S.A.





SHALLOW WELL LIFT PUMPS

Like the pitcher pump, shallow well lift (or suction) pumps can draw water from depths of up to 7m. They are suitable for cistern and shallow well applications. The basic design shown left, uses a two-pivot hand lever which, via the pump rod, operates the piston inside the cylinder incorporated in the pump stand. The pump should be installed at a height convenient to the user(s).

INTERSIGMA MODEL N-P This cast iron model, illustrated left, has a bronze cylinder. Plain bearings are used for the pivots, the main pivot being fastened with cotter pins. Two cylinder sizes available, 75mm and 90mm giving capacities of 28 and 40 litres/min respectively at 40 strokes/min. Weight 17kg.

SIGMA PUMPING EQUIPMENT
Valves Manufacturing Works
Václoslo nám c 60
P.O. Box 1111, 11187 Praha 1
CZECHOSLOVAKIA

GOLDEN HARVEST MODEL SB 38-1 Shown below left is made mainly of cast iron and has a porcelain enamelled *lining to its 100mm cylinder. Capacity 50* litres/min at 45 strokes. Weight 18kg.

CHINA NATIONAL MACHINERY IMPORT & EXPORT CORPORATION
Kwangton Branch
61 Yanjiang, Kwangchow, CHINA

CIECO MODEL SWP I This range of shallow well pumps is similar to the *Intersigma but has the cylinder smooth-*bored in the cast iron pump stand. Three sizes available: SWPI-4 with a 75mm diameter cylinder has a capacity of 17 litres/min; SWPI-5, 82mm, 20 litres/min; and SWPI-6, 90mm 28 litres/min.

CENTRAL INDIA ENGINEERING CO.
2153/5 Hill Street, Ranigunj
Secunderabad 500 003 A.P., INDIA
INDIA

KUMAR LIFT HANDPUMPS Similar to the CIECO model they are available with cylinder sizes from 64 to 89mm and capacities from 16 to 32 litres/min. Weight 12 to 30kg.

KUMAR INDUSTRIES
Edathara Post 678 611
Palghat District, Kerala, INDIA

'LAGO' LIFT HANDPUMP Specially recommended for shallow wells up to 7m this range of cast iron pumps is available in five sizes: 70 to 100mm with capacities of 17 to 33 litres/min. Weight 11 to 25kg.

FABRICA DE IMPLEMENTOS AGRICOLAS (FIASA)
Hortiguera 1862, 1406 Buenos Aires
ARGENTINA

LEE HOWL LIFT PUMP A cast iron pump similar to the above model has an 80mm cylinder which can be connected to either a 40mm or 50mm suction pipe. A variation with lugs on the pump body is available for wall or board mounting.

LEE HOWL & CO. LTD.
Alexandra Road, Tipton
West Midlands, U.K.

BANGLADESH NEW NO.6 PUMP This simple, robust shallow well suction pump connects directly to a 38mm suction pipe. Illustrated above right it is constructed almost entirely of cast iron. Originally conceived as a domestic water supply handpump it has been used extensively in Bangladesh for low-lift irrigation. Weight 31kg.

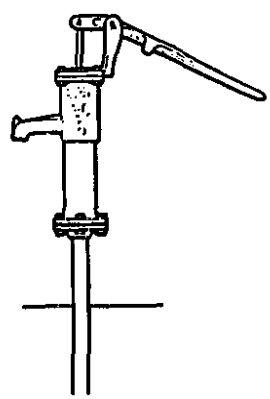
ENGINEERS WOOD STEEL INDUSTRIES
67 Tejgaon Industrial Area
Dhaka 6, BANGLADESH

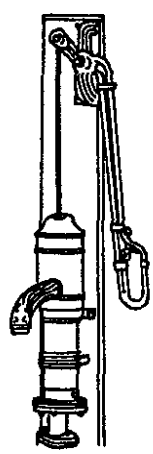
BANDUNG PUMP A shallow well suction pump similar to the New No.6 pump, has *a 96mm enamelled steel cylinder liner* incorporated into the cast iron stand. Capacity 28 litres/min at 40 strokes. Weight 25kg.

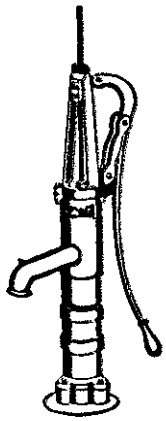
IWACO B.V., P.O. Box 183
3000 AD Rotterdam, NETHERLANDS

'ARDENNAISE' PUMP Specially designed for board or wall mounting, this shallow *well pump is illustrated below right.* 'American' model also available for wall or stand fitting.

RENSON ET CIE
BP 23, 59550 Landrecies, FRANCE





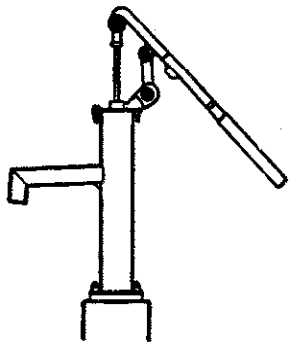


CIECO MODEL SWP II

This shallow well lift pump has a three-pivot handle mechanism and an adjustable double guide arrangement to ensure vertical movement of the pump rods and piston, thereby minimizing wear. The totally enclosed pump head is fitted with a gland nut and packing to prevent leakage of water. The all-iron piston has a single leather 'bucket' seal and valve of galvanized steel and the cylinder a leather flap check valve.

Two models are available: the SWP II-4 with a 76mm diameter cylinder has a capacity of 17 litres/min. at 50 strokes, the SWP II-6, 88mm, 28 litres/min. Both models are fitted to connect with a 38mm suction pipe. Lift and force model SWP IV also available for lifts up to 7m and forcing to 11m. Capacity 16 litres/min.

CENTRAL INDIA ENGINEERING CO.
2153/5 Hill Street, Ranigunj
Secunderabad, 500 003 A.P.
INDIA



LIFT PUMPS

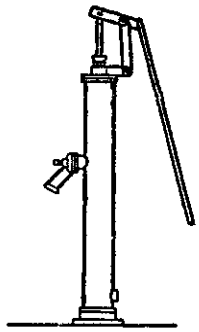
These two makes are for shallow well use and have a three-pivot handle system with rod guide and stuffing box for assisting vertical reciprocating motion and reducing wear.

INALSA Available in two sizes, the pump is illustrated left.

INDUSTRIAL AND ALLIED SALES PRIVATE LTD.
Suryakiran Building
19 Kasturba Gandhi Marg
P.O. Box 206
New Delhi 110 001
INDIA

MONITOR Model 11HA has a cylinder diameter 63.5mm and output 19 litres/min at 40 strokes.

BAKER MONITOR DIVISION
133 Enterprise St.,
Evansville
Wisconsin 53536
U.S.A.



LIFT AND FORCE PUMPS

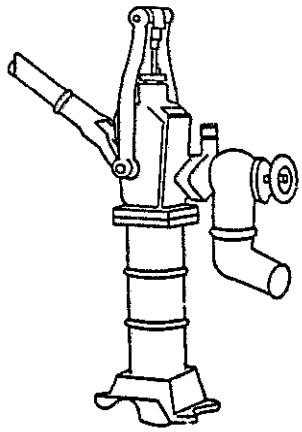
Similar to the two models left, these two makes have valved outlet, three-pivot handle system, rod guide and stuffing box.

GODWIN SERIES HLS Illustrated above. Available with cylinder sizes 63.5 and 90mm. Output 23 and 44 litres/min at 40 strokes.

H.J. GODWIN LTD.
Quenington, Cirencester
Glos. GL7 5BY
U.K.

GERA G-60 The double-acting cast iron model shown below is suitable for lifts up to 7m and force delivery to 12m and output 20 litres/min.

KASAMATSU S.A.
Comercial & Industrial
Chile 452 — Piso 20 Edificio Victoria
Casilla de Correo No. 52, Asunción
PARAGUAY



SHALLOW WELL LIFT AND FORCE PUMPS

These handpumps are capable of lifting water from depths of up to 7m and delivering it to an elevated position. The two pumps listed here have a three-pivot yoke-type handle system, valved outlet and rod guide and stuffing box.

GOLDEN HARVEST SB 40-1 Illustrated left. Cylinder diameter 84mm. Output 32 litres/min at 40 strokes.

CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing
CHINA

DRAGON No.2C Fitted with a three-way spout this pump has an output of 28 litres/min at 40 strokes. Weight 21kg.

AWAMOTO PUMP MFG. CO.
P.O. Box Nagoya Naka No25
Nagoya
JAPAN

SHALLOW WELL HANDPUMP

Commonly used as a household pump for drinking water provision and for watering vegetable plots. Construction details available from:

G.I.A.
Ricardo Matte Pérez 0324
Casilla 6122, Correo 22
Santiago
CHILE

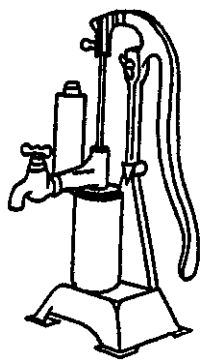
HOUSEHOLD LIFT AND FORCE PUMPS

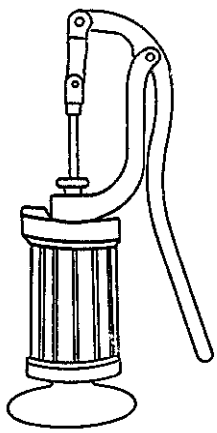
HOUSE FORCE PUMP For use on kitchen sink and for forcing water to an elevated tank. Made of red cast iron with a 76mm brass cylinder. Illustrated right.

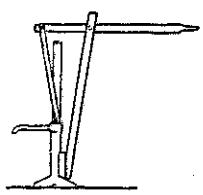
CUMBERLAND GENERAL STORE
Rt. 3 Box 479, Crossville
TN 38555
U.S.A.

CIECO DOMESTIC WATER PUMP MODEL DWP A vertical reciprocating type plunger pump which can be connected onto municipal water line for lifting water to higher levels. Four sizes available.

CENTRAL INDIA ENGINEERING CO.
2153/5 Hill Street, Ranigunj
Secunderabad 500 003 A.P.
INDIA



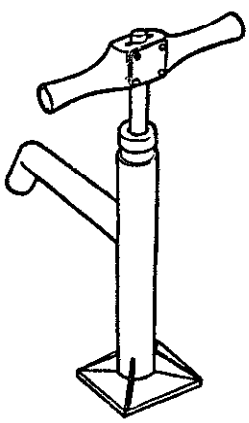




KENYA HANDPUMP

The wooden pump handle is linked with the connecting rods to the pump rod. The upper part of the pump rod fits in a guide pipe to limit lateral movement. Cylinder available in several sizes. Output 28 litres/min at 22 strokes. Deep well version also available.

ATLAS COPCO KENYA LTD.
P.O. Box 40080, Nairobi
KENYA



DIRECT ACTION HANDPUMPS

These innovative shallow well domestic pumps are operated directly by pushing and pulling on the 'T' handle, thus avoiding the complexities of the more conventional 2 or 3 pivot handle systems. The designs are aimed at lowering costs and facilitating maintenance at the village level. With modification they can operate at depths of up to 15m.

ETHIOPIA TYPE BP50 Illustrated left, makes extensive use of plastic materials: cylinder 51mm UPVC water pipe extending to the surface as the rising main; piston HDP; pump rods UPVC pipe.

EWWCA, UNICEF
P.O. Box 1169, Addis Ababa
ETHIOPIA

MALAWI SHALLOW WELL PUMP Normally used on wells up to 6m, this pump, like the former, has many plastic components.

MALDEV PETROLEUM SERVICES (Malawi Ltd.), Box 1900
Blantyre
MALAWI

BLAIR PUMP Features a down-turned handle cum delivery spout. Incorporates a combination of steel and PVC parts.

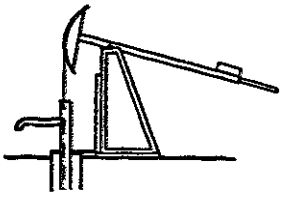
PRODORITE (PVT) LTD.
21 Leyland Rd.
Ardbennie Industrial Sites
P.O. Box 2887, Harare
ZIMBABWE

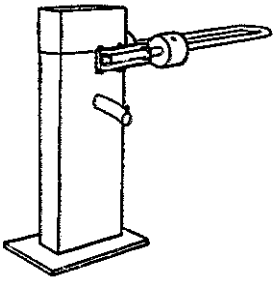
TARA PUMP This design, capable of lifts up to 15m has evolved from experience with PVC pumps in Malawi, Ethiopia and Bangladesh.

UNICEF, BANGLADESH
P.O Box 58, Dhaka 5
BANGLADESH

DOMESTIC HANDPUMPS

By positioning the cylinder and piston assembly (or alternative pumping mechanism) below ground, either submerged or close to the water level, these pumps are suitable for depths of up to 60m. Greater depths are possible with some models, up to a maximum of 120m. An extensive range of equipment is available, examples of which are described in the following four pages.





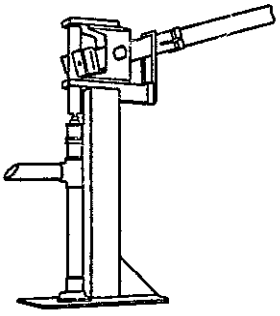
CABLE-OPERATED HANDPUMPS

SISMAR HANDPUMP This single-pivot model, illustrated far left, is mostly steel. A cable on a quadrant connects with the piston inside the extractable cylinder. Two sizes available: 51 and 76mm with outputs of 25 and 58 litres/min respectively and maximum lifts of 70 and 30m. Heavy-duty handle can be operated simultaneously by up to 4 people.

SISMAR
B.P. 3214, Dakar
SENEGAL

NEPTA PUMP This design, illustrated left, uses a similar operating mechanism to the above model. Six cylinder sizes available for different pumping depths. E.g. 140mm for 9m with output 83 litres/min; 40mm for 100m, output 9 litres/min.

BRIAU SA
B.P. 43
37009 Tours Cedex
FRANCE

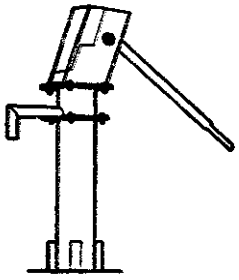


B AND C MODEL II HANDPUMP

The deep well handpump illustrated above is fabricated mainly from steel and has a single-pivot wooden handle with a guide and roller arrangement to achieve vertical reciprocating motion of the pump rods and piston. Heavy-duty roller bearings are used at the pivot to accommodate pump handle forces without undue friction and wear.

The piston is fitted with neoprene cup seals and operates inside a 77mm brass cylinder. The rising main (or drop pipe) has a 50mm bore and the minimum recommended well casing diameter is 150mm. Output 7 litres/min. Maximum lift 60 to 75m.

BROWN & CLAPPERTON LTD.
P.O. Box 1562, Blantyre
MALAWI



INDIA MARK II DEEP WELL HANDPUMP

This robust pump, fabricated from steel plate has been developed by UNICEF in India from an original design by the Sholapur Well Service. Illustrated above, it results from efforts to produce on a large scale a strong and reliable pump which can be maintained in operational order at village level. Its distinguishing feature is the single-pivot handle system with quadrant and heavy-duty roller chain connecting to the pump rods which facilitates vertical reciprocating motion. The pivot is fitted with sealed ball bearings to minimize friction and wear, and the heavy-duty handle, designed to give a mechanical advantage of 8:1, helps to counterbalance the pump rod weight and improve operator comfort.

The cast iron cylinder is fitted with a 63.5mm brass liner and the piston with high quality leather cup washers. The rising main is 32mm. Suitable for fitting to wells or borehole casings from 102 to 127mm and depths up to 70m. Output 13 litres/min at 40 strokes.

Available from the following manufacturers:

ACHIEVE ENGINEERING WORKS
C-294 Peenya Industrial Estate
Bangalore 560 058, Karnataka
INDIA

ADROIT INDUSTRIES
19-B Industrial Area, Richhai
Jabalpur, Madhya Pradesh
INDIA

AJAY INDUSTRIAL CORPORATION
4561, Deputy Ganj, Sadar Bazar
Delhi 110 006
INDIA

BALAJI INDUSTRIAL & AGRICULTURAL CASTINGS
P.O. Box No. 1634
Secunderabad 500 003 A.P.
INDIA

CENTRAL INDIA ENGINEERING CO.
2153/5 Hill Street, Ranigunj
Secunderabad 500 003 A.P.
INDIA

GREYSHAM (INTERNATIONAL) PVT. LTD.
4-B Vanhna, 11 Tolstoy Marg
New Delhi 110 001
INDIA

JANATHA INDUSTRIAL CORPORATION
8-3-224 Yousufguda Road
Hyderabad 500 873
Andhra Pradesh
INDIA

M.M. & CO. (ENGINEERS)
B-30 Industrial Estate
Cuttack 753 010, Orissa
INDIA

INDUSTRIAL & ALLIED SALES PVT. LTD.
19 Kasturba Ghandi Marg
P.O. Box 208, New Delhi 110 001
INDIA

SENCO INDUSTRIES
A-12, Coimbatore Private Ind. Estate
Coimbatore 21
INDIA

SHOLAPUR WELL SERVICE
560/59 South Sadar Bazaar
Civil Lines
Sholapur 413 003, Maharashtra
INDIA

SONTHALIA INDUSTRIES
23/24 Radna Bazar Street
3rd Floor, Calcutta 700 001
INDIA

SOHAM ENGINEERING CORPORATION
Gurudev Engineering Co.
1-7-1054 Industrial Area
Azambad, Hyderabad 500 020
Andhra Pradesh
INDIA

SURAYA BHARAT INDUSTRIES
58 Craftsmen Guild, Mallepally
Hyderabad 500 047
Andhra Pradesh
INDIA

VARUN ENTERPRISES
17-19 Parvati Nagar
Tonk Fatak, Jaipur 302 004
Rajasthan
INDIA

PRAKASH ENGINEERING ENTERPRISES
A-1983, Peenya Industrial Estate
Bangalore 560 058, Karnataka
INDIA

RAJASTHAN STATE AGRO INDUSTRIES CO. LTD.
Virat Bhavan, Prithviraj Marg
C-Scheme, Jaipur 302 001
Rajasthan
INDIA

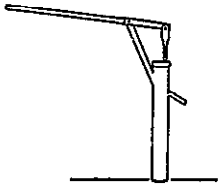
RICHARDSON & CRUDDAS (1972) LTD.
P.O. Box No. 1275
Madras 600 001
INDIA

VARUN ENTERPRISES
27-28-29 M.P.L.U.N. Sheds
Govindpura Industrial Estate
Bhopal, Madhya Pradesh
INDIA

TAMIL NADU SMALL INDUSTRIES CORPORATION (TANSI)
1 Whites Road
Madras 600 014, Tamil Nadu
INDIA

pb — MARK II HANDPUMP Identical to the India Mark II deep well handpump. Manufactured by:

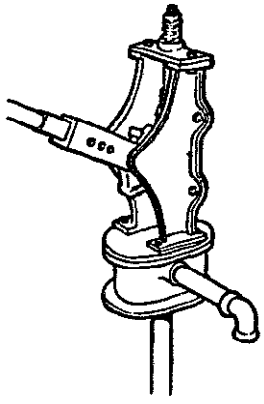
PUMPENBÖSE K.G.
P.O. Box 1250, 3006 Burgwedel 1
W. GERMANY



BOLIVIANA HANDPUMP

This pump has a simple two-pivot handle system. The pump stand is made from steel [illegible] the rising main from 51mm [illegible] which also serves as the cylinder. Suitable for depths up to 14m. Output 8 litres/min at 40 strokes.

INSTITUTO DEL DESAROLLO RURAL DEL ALTIPLANO
Edificio Esperanza 8° piso
Casilla 8561 La Paz
BOLIVIA

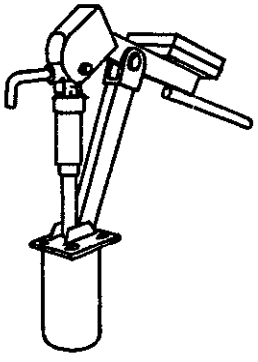


KORAT 608 A-1 PUMP

This robust deep well pump is manufactured in Thailand. The pump head, shown left, is mainly cast iron. A wooden handle operates a rack and quadrant mechanism which achieves vertical reciprocating motion of the steel pump rods and piston. The cylinder is a seamless brass tube and the piston has two conventional leather cup seals. There are two foot valves, one in the base of the cylinder, the other at the end of a short dip tube below.

For installation, the pump stand which weighs 47kg, must be mounted on a plinth at a suitable height for filling water containers. A 38mm bore rising main is recommended and the maximum outside diameter of the below-ground assembly is 90mm.

SAHA KOLKARN FACTORY
94-96 Soi Sukapiban 2
Ramintra Bangkhen, Bankok
THAILAND

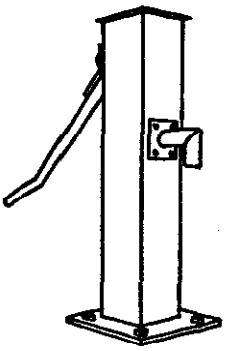


WELLDRILL HANDPUMP

This design, illustrated left, has an unconventional pumping element comprising a special wire-reinforced rubber diaphragm tube which when deformed by stretching decreases in volume and produces a pumping effect. The counterweighted handle is connected to the rubber tube by a pipe which serves as a combined pump rod and rising main. By pushing down the handle the tube is stretched and water is forced to the surface past a discharge check valve. When the handle is lifted the tube increases in volume and water enters through a suction check valve. An anchor arrangement secures the diaphragm tube in the well casing so that the stretching force can be resisted.

Installation depth 10 to 60m. Well diameter 100 to 140mm (150 to 190mm optional). Capacity 12 litres/min at 40 strokes.

WELLDRILL SYSTEMS AB
Tagenevägen 21
S-42590 Hisings Kärra
SWEDEN



CONSALLEN HANDPUMP

The working parts of this deepwell reciprocating piston pump are made from stainless steel, brass, bronze and plastic. The robust pump stand is fabricated from steel plate and the two-pivot handle is fitted with sealed-for-life roller bearings. Stainless steel pump rods connect the handle to the piston which operates inside a stainless steel cylinder. 51mm ABS pipe is solvent jointed and put into the well or borehole as a continuous length rising main which permits the piston and the combined footvalve and strainer unit to be extracted should this be necessary.

Suitable for wells or boreholes up to 60m. Three cylinder sizes available: 50, 63 and 75mm for maximum depths of 60, 45 and 30m respectively. Output 18, 28 and 41 litres/min at 45 strokes.

CONSALLEN STRUCTURES LTD.
291 High Street, Epping
Essex CM16 4BY
U.K.

DEEP WELL PUMPS

GSW DEEPWELL HANDPUMP 1205 X This model, fabricated mainly from steel is shown right. The two-pivot handle fitted with sealed ball bearings operates the piston inside a 63.5mm brass cylinder. Maximum lift 40m. Output 14 litres/min at 22 strokes. Weight 25.5kg.

GSW LTD.
1183 Finch Avenue West, Suite 307
Downsview, Ontario M3J 2G2
CANADA

BONZA MK2 HANDPUMP A new design using modern materials to overcome corrosion and wear problems. Sealed-for-life roller bearings; PTFE-lined GRP cylinder (50mm); composite piston; lightweight pultruded GRP pump rods; and *ABS or UPVC rising main. Maximum lift* 65m. Capacity 12 litres/min at 40 strokes.

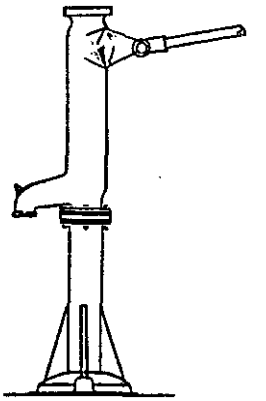
MARCH MAY LTD.
Eaton Works, Howard Road
Eaton Socon, Huntingdon
Cambridgeshire PE19 3ET
U.K.

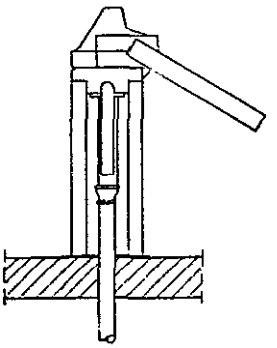
NIRA AF-76 Made mainly from cast iron, this handpump has a two-pivot handle with stainless steel pins running in bronze couplings. Stainless steel pump rods connect to a brass piston fitted with a nitril rubber seal, which operates inside the 76mm brass cylinder. Maximum lift 36m. Output 50 litres/min.

VAMMALAN KONEPAJA OY
38200 Vammala
FINLAND

AFRIDEV DEEP WELL HANDPUMP The pump rods, piston and foot-valve of this pump can be readily be withdrawn through the pump head. Mass production of these components from injection moulded plastic is planned so that inexpensive spares will be available, making village level maintenance a *viable proposition. The handle, which* has a "T" end, is fitted with sealed ball bearings at both pivots.

PETROLEUM SERVICES (MALAWI) LTD.
P.O. Box 625, Blantyre
MALAWI





ABI TYPE M HANDPUMP

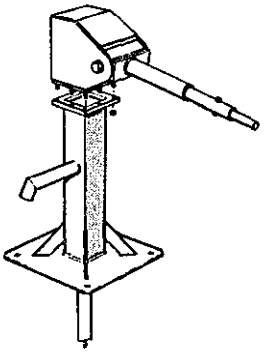
Illustrated left, this model uses a combination of cast iron and fabricated steel section for the pump stand. Two castings house sealed ball bearings for the two-pivot handle which connects to steel pump rods. Three (brass) cylinder sizes available: 60, 70 and 80mm for lifts of 30m upwards, 13 to 30m, and 0 to 12m with outputs of 17, 23 and 30 litres/min respectively.

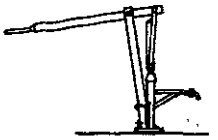
ABIDJAN INDUSTRIES S.A.
B.P. 343
45 rue Pierre et Marie Curie
(Zone 4c), Abidjan
IVORY COAST

Other agents for this pump are:

SOMEA
B.P. 724, Bamako
MALI

SAFICOCI
B.P. 1117, Abidjan
IVORY COAST





KENYA DEEP WELL HANDPUMP

Similar three-pivot design to the shallow *well version but with U-bolts for fixing* directly to borehole casing. Four cylinder sizes: 46, 57, 70 and 100mm for maximum depths of 60, 50, 25 and 15m respectively. Output 7, 10, 15 and 28 litres/min at 22 strokes.

ATLAS COPCO KENYA LTD.
P.O. Box 40080, Nairobi
KENYA

SUMBER BANYU PUMP

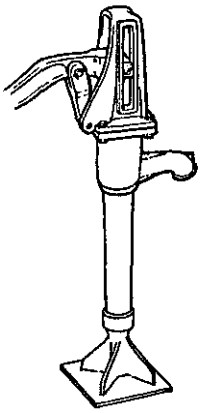
Illustrated right, this model is a derivative of the AID/Battelle deep well design. The pump stand is steel tube with a cast iron head incorporating a sliding crosshead in the three-pivot handle mechanism to achieve vertical reciprocating motion. The pump is fitted with a UPVC cylinder and GI rising main.

CELCO INDUSTRIAL CO.
43A Jl. Jendral Gatot Subrato
Bandung
INDONESIA

Manufacturers of the similar AID type deep well handpump include:

ETINCA
Equipo Technico Industrial, C. por A.
Calle San Juan de la Maguana No. 102
Villas Agricolas, Apartado No. 158-12
Santa Domingo
DOMINICAN REPUBLIC

SOMASIRI HULLER MANUFACTORY
18 Parakrama Avenue
Kohuwala, Nugegoda
SRI LANKA



SWN HANDPUMPS

Two deep well models are available, the standard SWN 80 for depths up to 40m and the SWN 81, shown above for depths up to 100m. Both use a two-pivot handle fitted with ball bearings or plain journal bearings. The pump stand is made from *galvanized square section steel tube and* the stainless steel pump rods connect to the down-the-well piston and cylinder assembly which features corrosion-resistant parts made from PVC, neoprene, nylon, brass and stainless steel. The rising main is 48/36mm high impact PVC. Four cylinder sizes available: 50, 63, 75 and 100mm with outputs of 0.3, 0.5, 0.7 and 1.25 litres/stroke. Other models from this manufacturer are the SWN Irrigation, a low-lift piston type handpump, and the Kangaroo MkII direct action handpump for lifts up to 15m.

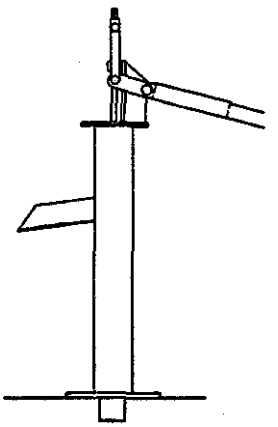
VAN REEKUM MATERIALS BV
Kanaal Noord 115, P.O. Box 98
7300 AB Apeldoorn
NETHERLANDS

B AND C MODEL I HANDPUMP

This deep well model which is illustrated right is fabricated mainly from steel section and steel plate. Its three-pivot handle system features a yoke-type linkage and incorporates a rod guide for maintaining pump rod alignment. The brass piston and cylinder assembly are identical to the model II version which is fitted with neoprene cup seals.

The minimum recommended size borehole casing for accepting the pump is 150mm. Output 7 litres/min. *Maximum* lift 45 to 60m.

BROWN & CLAPPERTON LTD.
P.O. Box 1582, Blantyre
MALAWI



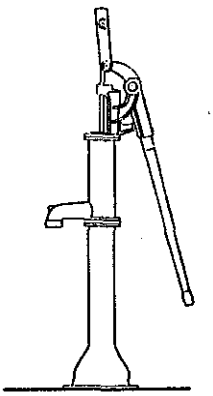
MONARCH P3

Made mainly from ductile cast iron this deep well handpump, shown right, has a similar three-pivot handle mechanism to the B & C Model I. Each of the pivots is *fitted with double sealed ball bearings* and two sintered bronze bushes guide the top of the pump rod. Brass or cast iron cylinders available, 89mm diameter. Pump stand fits well casings from 100 to 150mm. Maximum lift 46m. Output 47 litres/min at 50 strokes.

MONARCH INDUSTRIES LTD.
889 Erin Street, P.O. Box 429
Winnipeg R3C 3E4
CANADA

GSW 1205 AFB Very similar to the above model. Additional strut supports pump stand. Steel tubing instead of wood for handle. 63mm brass cylinder. Maximum lift 40m. Output 14 litres/min.

GSW LTD.
1183 Finch Avenue West, Suite 307
Downsview, Ontario M3J 2G2
CANADA



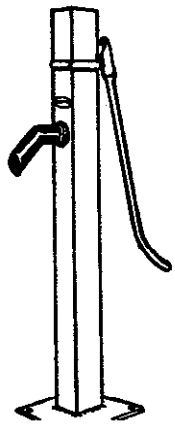
BARNABY CLIMAX DEEP WELL HANDPUMP

This new design, illustrated right, uses a three-pivot linkage to transfer movement of the hand lever into vertical reciprocating motion of the pump rods and piston. Manufactured by:

BARNABY CLIMAX LTD.
White Ladies Close, Little London
Worcester WR1 1PZ
U.K.

Also marketed by:

THOR IMPORTS AND EXPORTS
Colmworth, Bedfordshire MK44 2JY
U.K.

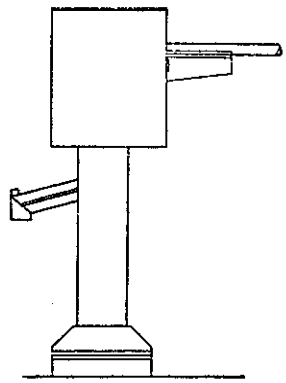


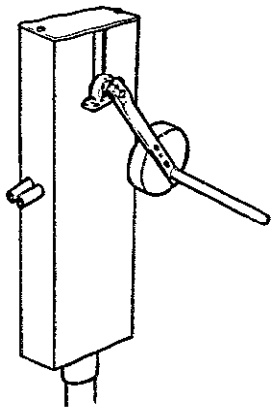
GSW 1205 GHANA MODEL

This model uses mostly cast iron and steel components. The pump stand, made from steel pipe is welded to a steel pressing which forms the base (illustrated right). Like the earlier GSW model, this design uses a three-pivot handle system with a yoke-type linkage which slides on double guide pillars to maintain pump rod alignment. The two upper bearings in the main pivot are sintered bronze lubricated by an oiled felt pad. The other pivots consist of plain pins turning in bronze bushes. Provision is made for three different handle positions in order to adjust the mechanical advantage.

The pump is fitted with a 63mm brass cylinder and 38mm galvanized steel rising main. Maximum lift 40m. Output 14 litres/min at 22 strokes.

GSW LTD.
1183 Finch Avenue West, Suite 307
Downsview, Ontario M3J 2G2
CANADA





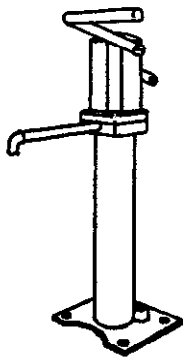
ROTARY CRANK HANDPUMPS

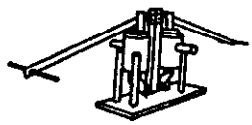
VEW A18 Shown left, this pump uses a cable rather than rods to transmit reciprocating motion to the piston. Twin handles with counterweights facilitate operation by two people. Weight 85kg.

VEREINIGTE EDELSTAHLWERKE
Franz Josefs — Kai 51
A 1011 Vienna, P.O. Box 56
AUSTRIA

SBF-TURNI illustrated right. Normal range 3.5 to 60m; maximum 90m. Choice of gear ratios available for different depths. Weight 75kg. Conventional hand lever model, SBF-KARDIA also available. Lift up to 40m. Output 17 litres/min at 40 strokes.

PREUSSAG AG
Abt. WW, P.O.B. 6009
3150 Peine
W. GERMANY

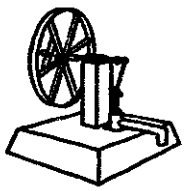




PULSA 3 HANDPUMP

This unusual new design uses rebound inertia to lift progressively an oscillating column of water. A piston and cylinder assembly at ground level are connected by a pressure hose to a submerged chamber fitted with a foot-valve and containing elastic elements. Lifts up to 50m. Output 8 litres/min.

FLUXINOS
Via Genoa 10, 58100 Grosseto
ITALY

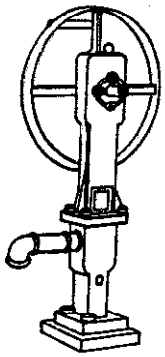


VOLTANA

A hand-cranked, flywheel-assisted, deep well reciprocating piston pump available from:

JANSEN VENNEBOER BV
P.O. Box 12
8130 AA Wijhe
NETHERLANDS

INSTO
37 Arkelstraat, P.O. Box 570
4200 AN Gorinchem
NETHERLANDS

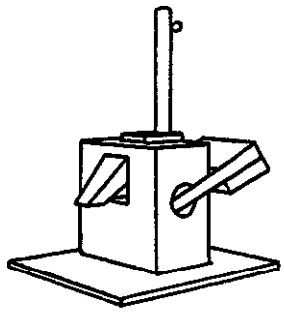


HMA COMMUNITY HANDPUMPS

This new range of deep well handpumps, illustrated left, uses a hand-turned, counterbalanced flywheel to achieve smooth reciprocating motion with minimum operating effort. The pump stand and head are made from heavy-section cast iron, with rotating parts in forged steel fitted with grease-packed sealed-for-life bearings. The adjustable pump rod slide bearing is made from oil filled bronze. The pump is normally supplied for lift duty only but can be converted to lift and force duty.

Extractable and non-extractable cylinders available in sizes from 45 to 102mm with stroke length of 51 or 102mm. Suitable for maximum heads of up to 98m or 124m with two operators. Output from 3.5 to 35 litres/min at heads of 96 and 14m respectively.

H. J. GODWIN LTD.
Quenington, Cirencester
Glos. GL7 5BY
U.K.



ROTARY HANDPUMPS

These differ fundamentally from the reciprocating piston type handpump. Instead of a piston and cylinder, the positive displacement pumping element consists of a helical rotor which rotates within a fixed stator, causing a 'progressing cavity' effect which moves water upwards. The rotary motion for the vertical drive-shaft is achieved through bevel gears turned by crank handles.

MONOLIFT DW-15 HAND DRIVEN BOREHOLE PUMP Shown on the right, this model has a cylindrical cast iron pump stand and sealed head fitted with a pair of crank handles and Nylatron gears which require no lubrication. Power is transmitted by a vertical steel 'flexishaft' which rotates inside the galvanized iron rising main. The pumping rotor is a double spiral made of hard chrome plated steel and the stator is a triple spiral moulded from resilient rubber. This combination can pump silty or sandy water with minimal wear.

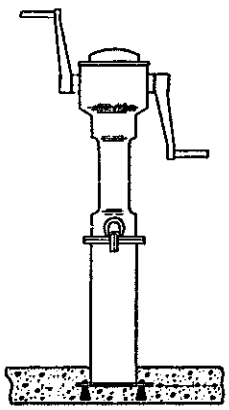
Suitable for depths of up to 60m. Maximum capacity 57 litres/min.

MONO PUMPS LTD.
Martin Street, Audenshaw
Manchester M34 5JA
U.K.

ROBBINS AND MYERS MODELS 1V12 and 2V12. Similar to the Monolift pump, these two models are suitable for depths up to 45 and 90m respectively. They can be fitted directly to borehole casings of 140mm or less. Cast iron bevel gears lubricated by oil bath. Output 8 litres/min at 50rpm.

ROBBINS AND MYERS INC.
Rural Water Systems
105 Willowbank Lane
West Chester, PA 19380
U.S.A.

ROBBINS AND MYERS CANADA LTD.
Rural Water Systems
P.O. Box 280
Brantford, Ontario N3T 5N6
CANADA

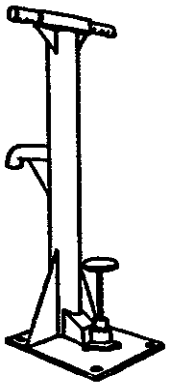


ALTAFLEX FOOT-OPERATED PUMP

This design, illustrated above, uses the same unconventional pumping element as the Well Drill Handpump. In this case, however, the pump is operated by treading on a counterweighted lever which is connected to the pump rod cum rising main by a length of steel cable guided on a quadrant to maintain vertical reciprocating motion.

Suitable for borehole casings measuring 102 to 107mm internal diameter. Depths up to 50m achievable. Capacity 17 litres/min at 30m lift and 60 strokes.

ETS. POMPES GUINARD S.A.
179 Boulevard Saint Denis
92402 Courbevoie
FRANCE

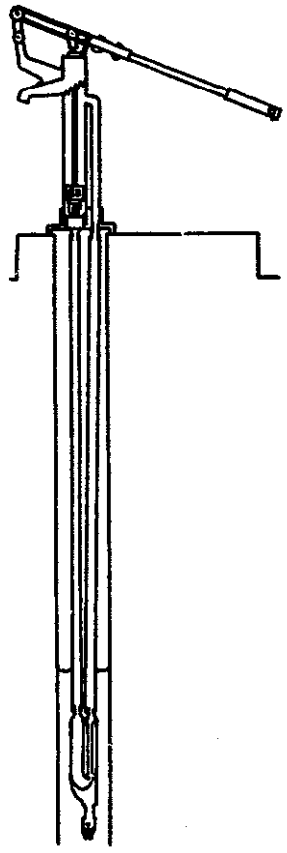


VERGNET HYDROPUMP

This deep well pump, available in hand- or foot-operated versions and illustrated left, uses a water-filled hydraulic system designed to facilitate installation and simplify maintenance. A drive hose connects the ground level cylinder to an elastic sleeve inside a submerged stainless steel cylinder. When the pedal is depressed, the elastic element expands and forces water out of the surrounding cylinder to the surface via the delivery hose. When the operating force is relieved the pedal rises as the element retracts and water enters the cylinder through the foot valve. Suitable for depths from 10 to 60m. Average delivery 20 to 8 litres/min respectively.

S.N.E. MENGIN
Zone Industrielle d'Amilly
B.P. 901, 45209 Montargis Cedex
FRANCE

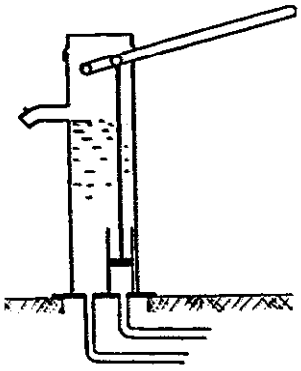
ABIDJAN INDUSTRIES S.A.
B.P. 343
45 rue Pierre et Marie Curie
(Zone 4c), Abidjan
IVORY COAST



JAMPH DEEP WELL HANDPUMP

This design, shown left, uses another hydraulic principle for its operation, the venturi ejector. It has a piston and cylinder incorporated in the pump stand connected to the submerged ejector nozzle and venturi unit by a 25mm flexible polyethylene pipe. When the handle is pushed down water is forced through the unit which draws more water in via the foot-valve and strainer. A 32mm polyethylene return pipe connecting the venturi outlet to the top of the pump stand delivers the pumped water. Suitable for depths up to 30m. Corresponding output 11 litres/min. Weight 36kg.

KENMAN CORPORATION
P.O. Box 966
Valdese, North Carolina 28690
U.S.A.



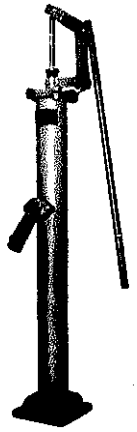
OMEGA HANDPUMP

Hydraulically operated, the above-ground part of this pump is shown left. The main piston, cylinder, spring and valve assembly is submerged in the well. Reciprocating motion is achieved by alternate hydraulic compression and extension of the spring. Two sizes available for 30 and 60m depths. Output 22 and 11 litres/min respectively.

BRIAU SA
B.P. 43
37009 Tours Cedex
FRANCE

MERRILL HANDPUMP This uses a similar principle to the Hydropump with the difference that the drive hose connects to the cylinder and the delivery hose to the diaphragm. Suitable for depths up to 80m. Capacity 8 litres/min.

MERRILL PUMPS & ENGINEERING CO. LTD.
Chapel Works, Sheffield Road
Sheepbridge, Chesterfield S41 9EH
U.K.



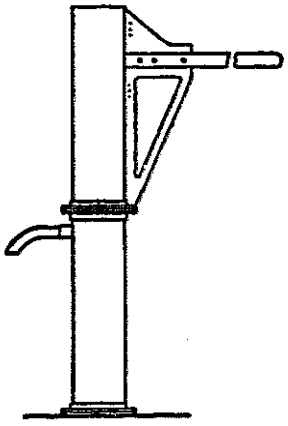
GODWIN HLD

The all-steel built deep well pump shown above has hardened steel bearing pins in its three-pivot handle system and a brass pump rod guide. Brass cylinder available in extractable or non-extractable types. Four sizes of each from 51 to 95mm with outputs from 14 to 50 litres/min at 40 strokes. Lift and force version also available.

H.J. GODWIN LTD.
Quenington, Cirencester
Glos. GL7 5BY
U.K.

LEE HOWL Similar to the above range. Five sizes available from 45 to 95mm for maximum lifts of 51 to 15m respectively. Corresponding outputs 5 to 22 litres/min at 30 strokes.

LEE HOWL & CO. LTD.
Alexandra Road, Tipton
West Midlands DY 8TA
U.K.

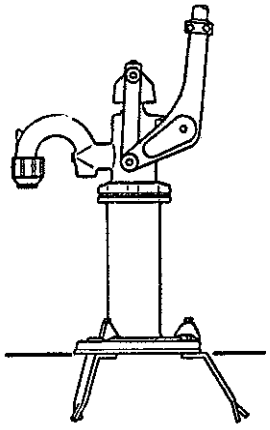


EDECO PUMP

The deep well pump shown above is fabricated mainly from tubular steel. It has a three-pivot handle system, fitted with sealed-for-life bearings, stuffing box and guide for alignment of the wooden pump rods. The main fulcrum for the counterweighted steel handle can be fitted in a choice of three positions in order to vary stroke length and alter the mechanical advantage for different operating depths. The pump cylinder is the extractable type made from brass lined gun metal. The rising main is 102mm galvanized steel pipe.

Four cylinder sizes available from 57 to 95mm for maximum lifts of 119 and 43m respectively. Corresponding outputs 11 to 32 litres/min at 25 strokes. The minimum size borehole for accepting this model is 140mm.

ENGLISH DRILLING EQUIPMENT CO. LTD.
Lindley Moor Road, Huddersfield
Yorkshire HD3 3RW
U.K.

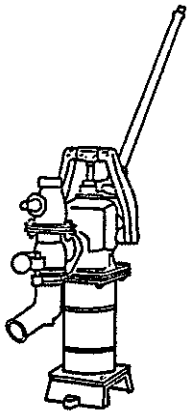


SOLO No. 3

This mainly cast iron deep well handpump, illustrated left, uses a three-pivot yoke-type linkage to achieve vertical reciprocating motion of the pump rods and piston. A stuffing box is incorporated in the pump head and stroke length can be varied by adjusting the main fulcrum position. The pivots consist of stainless steel pins in plain self-lubricating bearings.

The 12mm galvanized iron pump rods connect to a cast iron piston fitted with a leather cup seal which operates inside the brass or PVC lined GI cylinder. Several sizes are available. The rising main is 32 or 38mm GI pipe. Maximum lift 60m. Output 11 litres/min at 60 strokes.

ETS. ANDRÉ BODIN
Usine des Regains
P.O. Box 29, 37150 Blère
FRANCE



LIFT AND FORCE PUMPS

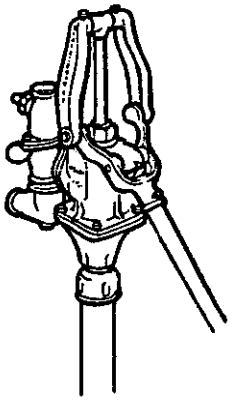
These handpumps are capable of lifting water from depths greater than 7m and forcing it to an elevated position. The two similar models listed here are made mainly from cast iron. Both use a three-pivot yoke-type handle system, valved outlet, rod guide and stuffing box.

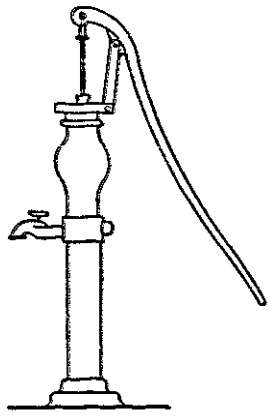
DRAGON NO. 2D. Basic model illustrated left. Can be adapted for lifting water from depths of up to 18m. Output 14 litres/min at 20 strokes.

KAWAMOTO PUMP MFG. CO. LTD.
P.O. Box Nagoya Naka No. 25
Nagoya
JAPAN

JETMATIC PUMP Manufactured under licence from Kawamoto pumps.

SEACOM INDUSTRIAL CORPORATION
30 Scout Tuason Street, Diliman
Quezon City
PHILIPPINES





LIFT AND FORCE PUMPS

The five models listed here are capable of both raising water and forcing it to a higher point. They have in common the following features: mainly cast iron construction; three-pivot handle system with stuffing box and pump rod guide; air chamber; and valved outlet spout.

CLAYTON MARK Illustrated left, this pump has a 32mm epoxy-lined galvanized steel cylinder. Suitable for depths up to 15m.

MARK CONTROLS INTERNATIONAL
1900 Dempster Street, Evanston
Illinois 60204
U.S.A.

DEMPSTER 23F(CS) Similar to the above design, this model has an extra long brass packing gland and an extended rod guide to provide maximum alignment. Pivots fitted with Nylatron and bronze bushes and stainless steel pins. Lift-only version (23F) suitable for depths up to 53m.

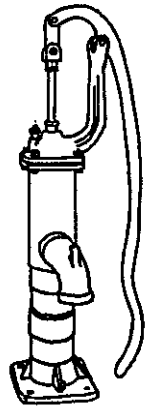
DEMPSTER INDUSTRIES INC.
P.O. Box 848, Beatrice
Nebraska 68310
U.S.A.

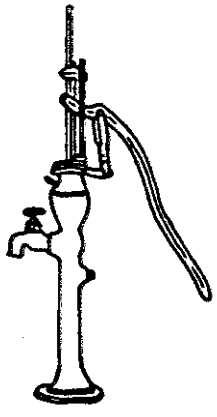
KUMAR LIFT-AND-FORCE PUMP Similar to design on right. Flange fitting on outlet accepts optional cast iron dome and brass tap.

KUMAR INDUSTRIES
Edathara Post 678 611
Palghat District, Kerala
INDIA

TROPIC HANDPUMP Illustrated right. Six cylinder sizes from 50 to 100mm. Capacity 12 to 48 litres/min at 40 strokes.

ASSOCIATION DEPLECHIN — DUBA
Nieuwstraat 31
B-9200, Wetteren
BELGIUM





PUMPS WITH GUIDE RODS

Similar to the above lift and force models the five listed here have two main additional features: adjustable fulcrum position for varying the mechanical advantage and stroke length; and extra pump rod guides to maintain vertical reciprocating motion.

JAL JAVAHAR PUMP Illustrated left. Pump rods operate vertically between twin parallel guide rods fitted to the pump head. Connects to a 76mm cylinder with 38mm rising main. Maximum lift 46mm; maximum delivery head 21m.

DANDEKAR BROTHERS
(Engineers & Founders)
Sangli — Shivaji Nagar, 416 416
Maharashtra
INDIA

DEMPSTER 210 F(CS) This heavy-duty hand and windmill model is designed for continuous deep well operation. Also available for lift-only (210F) and for normal duty (226F, illustrated right).

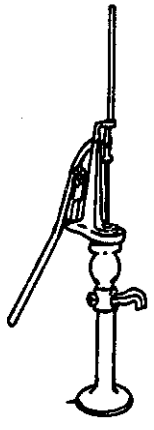
DEMPSTER INDUSTRIES INC
P.O. Box 848, Beatrice
Nebraska 68310
U.S.A.

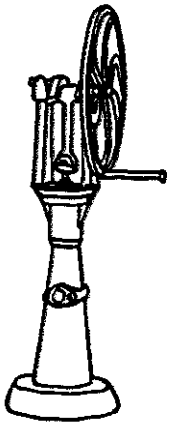
'LAGO' MODEL 203 Similar to the above design. Stroke adjustable to four positions: 305, 356, 406 and 457mm. Four cylinder sizes available from 57 to 76mm for maximum total head 37m.

FABRICA DE IMPLEMENTOS
AGRICOLAS (FIASA)
Hortiguera 1882
1406 Buenos Aires
ARGENTINA

MONITOR MODELS HD and HB Similar to the pumps above. HD lift and force version suitable for total heads up to 100m. HB for lift-only.

BAKER MONITOR DIVISION
133 Enterprise Street
Evansville, Wisconsin 53536
U.S.A.





FLYWHEEL ASSISTED LIFT-AND-FORCE PUMPS

The provision of a single or pair of ungeared flywheels on these models permits pumping from very deep wells by one or more operators.

GUILLAUD DEEP WEEL PUMP Shown left, this model is made mainly from cast iron. Reciprocating motion of the pump rods, guided by a stuffing box, is achieved by crank shaft connected directly to the hand-turned flywheel. A second flywheel can be fitted. Four cylinder sizes are available from 63 to 102mm for matching lifts from 45 to 10m. Weight approximately 95kg.

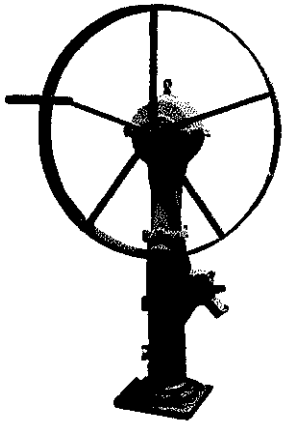
ETS. LOUIS GUILLAUD ET CIE
31 rue Pierre Parent, Casablanca
MOROCCO

GODWIN SERIES X Illustrated right. Reciprocating motion on this heavy-duty, mainly cast iron, double flywheel model is achieved by twin connecting rods and crosshead. Fitted with balance weights, the handwheels are extra wide for optional belt drive. Extractable or non-extractable cylinders available in eight sizes from 57 to 102mm for matching maximum heads from 53 to 12m. Corresponding outputs 13 and 41 litres/min at 40 strokes, the former with two operators.

H.J. GODWIN LTD.
Quenington, Cirencester
Glos. GL7 5BY
U.K.

BARNABY CLIMAX LIFT AND FORCE PUMP Similar to the Godwin Series X. Lubrication of the crankshaft ball bearings is by a force fed self-oiling system.

BARNABY CLIMAX
White Ladies Close
Little London, Worcester WR1 1PZ
U.K.



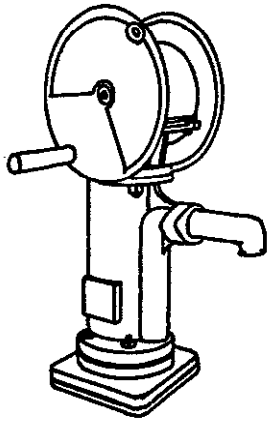
TROPIC TYPE III

Illustrated right this model is made mainly from cast iron. The solid double flywheels connect directly to the totally enclosed crankshaft and drive mechanism. No oiling or greasing required. Six cylinder sizes available from 50 to 100mm for depths of 50 to 15m. Corresponding capacities 13 to 53 litres/min at 50 strokes.

ASSOCIATION DEPLECHIN-DUBA
Pompes Deplechin
Avenue de Maire 28, 7500 Tournai
BELGIUM

'AFRICA' PUMP A totally enclosed deep well pump fitted with two flywheels. Suitable for depths of up to 100m. Output from 5 to 83 litres/min.

BRIAU SA
B.P. 43
37000 Tours Cedex
FRANCE



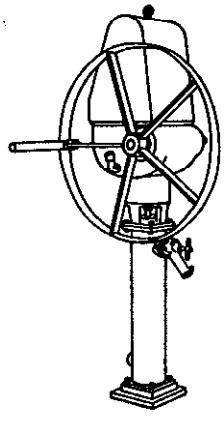
GODWIN SERIES W1H

The lift capability of this double flywheel lift and force pump, shown right, is increased by the addition of a gearbox. Wide hand-wheels permit belt drive. Same cylinder choice as Series X. Maximum head range from 107 to 20m. Corresponding outputs 7.5 to 24 litres/min at 20 strokes, the former with two operators.

H.J. GODWIN LTD.
Quenington, Cirencester
Glos. GL7 5BY
U.K.

TROPIC TYPE II A heavy-duty, geared double flywheel lift and force pump suitable for very deep wells. Cylinder sizes from 50 to 100mm for lifts of 95 to 25m. Corresponding capacities 11 to 42.5 litres/min.

ASSOCIATION DEPLECHIN-DUBA
Pompes Deplechin,
Avenue de Maire 28, 7500 Tournai
BELGIUM

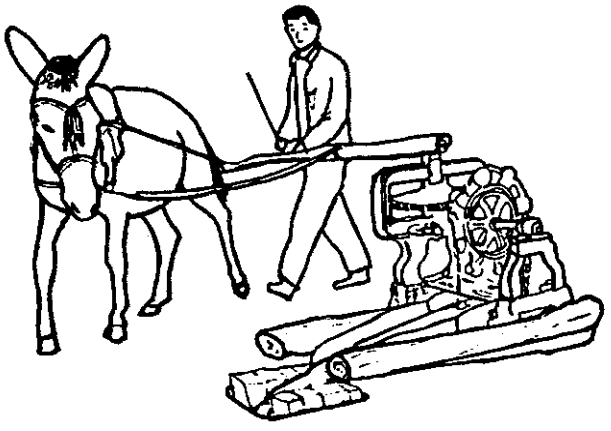


ANIMAL-POWERED IRRIGATION PUMPS

CHAIN AND WASHER PUMPS Widely used for irrigation in China, they consist of a rising main through which an endless chain, fitted with washers at regular intervals, is made to move by rotation of the chain wheel. The washers may be fitted with rubber discs or O rings to achieve a closer fit in the rising main. As they move up through the pipe they elevate the water to the surface. Unsuitable for narrow tubewells owing to space needed for the circulating chain.

TUBE-CHAIN WATERWHEEL The model shown on the right is known as the Light Liberation type which can be powered by a single draught animal. The bevel gear transmission is mounted in a cast iron frame. The chain washers are fitted with easily replaceable rubber O rings. A non-return pawl prevents the chain from running backwards. Maximum lifting head is 12.5m. Capacity is 6.8m³/h at 4rpm of the input shaft. Total weight 217kg. Minimum recommended well diameter 0.8m. Also adaptable through speed-reduction mechanism for use with electric motor or small engine (3 to 4kW). Maximum lifts of 15 to 20m attainable. Corresponding capacities 36 and 30m³/h. Made by Shanxi Hydraulic Machinery Factory and available through:

CHINA NATIONAL MACHINERY IMPORT AND EXPORT CORPORATION
Kwangton Branch
61 Yanjiang, Kwangchow
CHINA



ANIMAL-DRAWN CHAIN PUMP This pump can lift water from depths of up to 13m. The gear shafts are fitted with ball bearings and the rubber washers are easily replaceable. It can be installed on wells of 1m or more diameter. Capacity 13 to 18m³/h. Weight 380kg.

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P., INDIA

ANIMAL POWERED MONOLIFT PUMP This rotary pump is an adaptation of the Monolift borehole pump. Suitable for maximum lifts from 30 to 110m depending on type and number of animals used. Maximum output ranges from 1.2 to 4.6m³/h.

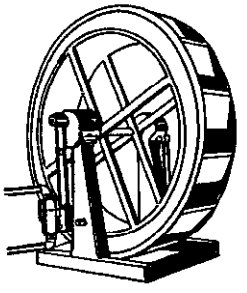
MONO PUMPS LTD.
Martin Street, Audenshaw
Manchester M34 5JA
U.K.

'AFRICA' PUMP This model which is described on the previous page can be adapted for use with animal (or engine) power.

BRIAU SA
B.P. 43
37009 Tours Cedex
FRANCE

ANIMAL POWERED WATERLIFTER A mobile unit powered by one heavy buffalo or two light bullocks, delivers 50m³/day at maximum head of 8m. Larger model with two heavy buffaloes has twice the capcity or approx. 18m³/h.

BÜNGER ENGINEERING LTD.
5260 Højby Fyn
DENMARK



WATER-WHEEL DRIVEN PUMPS

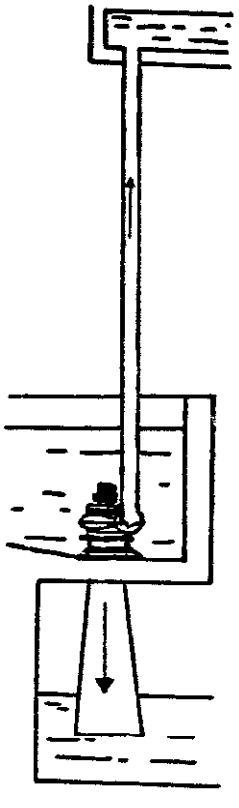
RODA D'AGUA The overshot water-wheel shown above drives two piston pumps situated at each end of the axle. Wheels of 1 and 2m diameter available for heads up to 80m and capacities from 2 to 6m³/h.

EICKHOFF-MÁQUINAS AGRÍCOLAS LTDA
Av. Santa Rosa 94, Caixa Postal 68
98.910 Tres de Maio R.S.
BRAZIL

BOMBAS HIDRÁULICAS ROCHFER This machine is made mainly from cast iron. Two horizontally opposed, variable stroke piston pumps are operated by a cross-head and eccentric. Four models available with wheel sizes from 110 × 13cm to 250 × 36cm for maximum heads of 80 and 130m and capacities up to 0.25 and 4.3m³/h respectively. Minimum flow required to operate wheel varies from 1 to 45 litres/s depending on head and discharge requirements.

INDUSTRIAS MECÁNICAS ROCHFER LTDA
Avenida José da Silva
3.765 Jardim Maria Rosa
Caixa Postal 194
C.E.P. 14.400 S.P.
BRAZIL

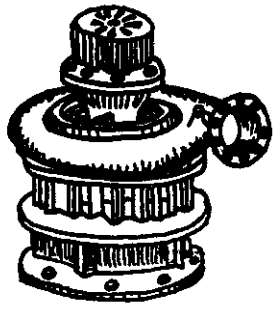
WATER TURBINE-PUMPS



The basic form of this machine is an axial-flow water turbine unit combined with a single-stage centrifugal or axial-flow pump mounted on the same shaft. The arrangement of a vertical installation is shown in the figure on the left and a typical turbine-pump is illustrated below right. More than 60,000 of these are reported to be in use in China irrigating approximately 400,000 ha. The turbine-pump which operates under totally submerged conditions gets its power from the flow of water through the turbine unit. This power is transmitted to the pump unit mounted immediately above which draws water from the same flow and discharges it into the delivery pipe. The turbine consists of an axial-flow propeller runner inside a casing which is designed to permit the working flow to smoothly enter the body through either fixed or adjustable guide vanes. The machine pit in which it is installed is usually situated at the end of a supply channel which is fitted with a trash guard and sluice gate for controlling water levels.

A wide range of turbine and pump combinations is available to meet the conditions and requirements found at different sites. Rivers, streams or springs with flows of at least 15 litres/s and where conditions exist for engineering a head of 0.5 to 20m will be suitable. There are three different series of machine classified according to the turbine's working head requirement: low head, 1 to 9m; medium head, 5 to 14m; and high head, 12 to 20m. Within each series there are many models. For example, the low head series have impeller sizes from 0.1 to 2.0m and develop shaft power in the range of 0.13 to 1500kW; matching pumps have delivery capacities from 1 litre/s to a lift of 6m up to more than 2.5m³/s to 48m.

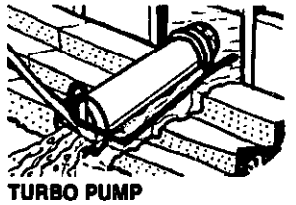
By installing two or more units in series or parallel the lift and discharge can be extended respectively. Also provision can be made for transmitting the shaft power by belt and pulley to other equipment such as agricultural processing machinery or an electricity generator.



There are several manufacturers of water turbine-pumps in China including the following: Kweichow General Machine Factory, Kweiyang; Youxi Turbine-Pump Plant, Fujian; and Hua Ning Turbine-Pump Factory, Hua Ning Xian.

Their equipment is exported by:

FUJIAN PROVINCIAL AGRICULTURAL MACHINERY
Import & Export Corporation
24 Dongda Road, Fuzhou
CHINA

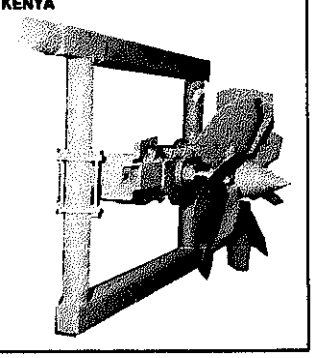


TURBO PUMP

This machine, powered by the energy of falling water, has been designed for pumping water from streams and rivers. The turbine part consists of a single impeller situated at the lower end of an inclined casing. It is turned by the action of the water flowing through — see figure and illustration above. The power is transmitted from a crank on the turbine shaft to the reciprocating pump unit which can be fitted with either 63.5 or 76mm cylinders.

A flow of 50 litres/s and a fall of 0.6m is sufficient to operate the pump, the maximum recommended fall being 0.9m. With a flow of 85 litres/s and a fall of 0.9m the pump can deliver approximately 3m³/h to a height of 3m or 0.6m³/h to a height of 60m.

NDUME AGRICULTURAL MACHINERY MANUFACTURERS LTD.
P.O. Box 62, Gilgil
KENYA



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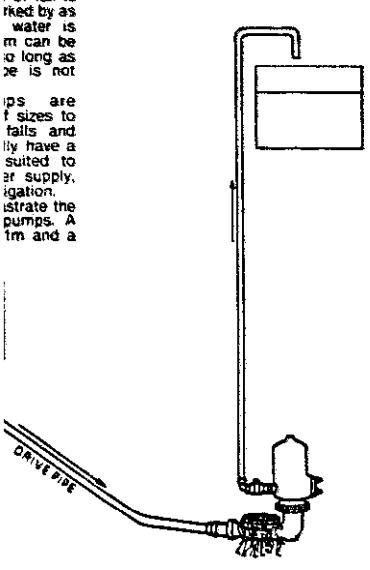
1m and a

working flow of 1 litre/s can deliver 0.07 litre/s to a head of 10m or 0.22 litre/s to a head of 3m. A 100mm ram with a fall of 15m and a flow of 4.5 litres/s can deliver 0.5 litre/s to a head of 90m or 1.5 litres/s to a head of 30m.

BILLABONG HYDRAULIC RAM Available in six sizes with drive pipe diameters from 25 to 102mm and capacities from 0.05 to 2.25m³/h.

JOHN BANKS & SON PTY. LTD.
Doody Street, Alexandria
Sydney, N.S.W.
AUSTRALIA



BRIAU HYDRAM 8 models available from 20 to 150mm.

BRIAU S.A.
B.P. 43
37009 Tours Cedex
FRANCE

AUTO LIFT IMPULSE PUMP Two sizes available 100 and 150mm.

GODBOLE & SONS
New Ramdaspeth, Kachipura
Nagpur — 1
INDIA

PREMIER HYDRAMS Three models available: 102, 152 and 203mm. Minimum recommended fall 1.2m; maximum 6m.

PREMIER IRRIGATION EQUIPMENT LTD.
17/1C Alipore Road
Calcutta 700 027
INDIA

CHANDRA HYDRAM Four sizes available from 25 to 102mm.

SINGH METAL CASTING WORKS
110 — D Nirala Nagar, Lucknow
INDIA

CECOCO HYDRO-HI-LIFT PUMP Six sizes available from 40 to 200mm (illustrated above left).

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

HYDRAULISKA VADURAR Seven sizes available from 13 to 76mm.

AB BRUZAHOLMS BRUK
57034 Bruzaholm
SWEDEN

JANDU'S HYDRAULIC RAM Six sizes available from 38 to 152mm.

JANDU PLUMBERS
P.O. Box 409, Arusha
TANZANIA

BLAKE HYDRAMS Ten sizes available from 32 to 200mm. Capacities up to 14m³/h and lifts up to 150m.

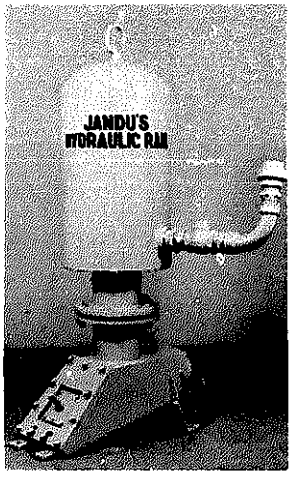
JOHN BLAKE LTD.
P.O. Box 43 Royal Works
Accrington, Lancashire BB5 5LP
U.K.

VULCAN RAMS Six sizes available from 32 to 102mm

GREEN & CARTER
Grange Farm, Northington
Alresford, Hants SO24 9TG.
U.K.

RIFE RAMS Three models available in various sizes up to 203mm.

RIFE HYDRAULIC ENGINE MANUFACTURING CO.
Box 367, Millburn, New Jersey
U.S.A.



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alternative installation using a submerged pump coupled by drive shaft to a surface-mounted electric motor. Other components which may be incorporated in the system between the array and the motor are an electronic control system, a battery and an inverter. Provision for water storage may also be desirable.

The following list prepared by IT Power Ltd. is for information only and does not imply any recommendation or endorsement of the products of any of the suppliers included.

AEG TELEFUNKEN
Industriestraße 29, 200 Wedel
W. GERMANY

ANSALDO (SOCIETA GENERALE ELETTROMECCANICA SpA)
via Nicola Lorenzzi 8
16152 Genova, Comigliano
ITALY

ARCO SOLAR INC.
20554 Plummer Street, Chatsworth
California 91311
U.S.A.

BRIAU S.A.
BP 43
37009 Tours Cedex
FRANCE

B.P. SOLAR SYSTEMS LTD.
Aylesbury Vale Industrial Park
Farmborough Close, Stocklake
Aylesbury, Bucks HP20 1DQ
U.K.

CENTRAL ELECTRONICS LTD.
4 Industrial Area
Sahibabad 201 010, U.P.
INDIA

EBARA CORPORATION
Asahi Building
6-7 Ginza 6-Chome
Chuo-Ku
Tokyo 104
JAPAN

GACUZZI BROTHERS
11511 New Benton Highway
Box 3533 Littlerock
Arkansas 72203
USA

GRUNDFOS
8850 Bjerringbro
DENMARK

HELIODINÂMICA
Caixa Postale 8085
01000
Sao Paulo
BRAZIL

IDL CHEMICALS
PB No 1, Sanatnagar (IE) PO
Hyderabad 500 018, A.P.
INDIA

KLEIN SCHANZLIN & BECKER AG
6710 Frankenthal, Pfalz
W. GERMANY

WILLIAM LAMB CO. INC.
P.O. Box 4165
North Hollywood, CA 91607
U.S.A.

LOWARA SpA
36075 Montecchio Maggiore, Vicenza
ITALY

MONEGON LTD.
4 Professional Drive
Suite 130, Gaithersburg, MD 20879
U.S.A.

MONO PUMPS LTD.
Martin Street, Audenshaw
Manchester M34 5JA
UK

NOLTE BV
Postbus 910, 5600 Ax Eindhoven
NETHERLANDS

PHOTOWATT INTERNATIONAL SA
96 ter blvd. Heloise
95102 Argenteuil
FRANCE

SHARP CORPORATION
22-22 Nagaike, Abeno-Ku
Osaka 545
JAPAN

SOLAR ELECTRIC INTERNATIONAL INC.
31 Queen Anne's Gate
London SW1H 9BU
U.K.

SOLARFORCE
179 blvd. Saint Denis
BP 320, 92400 Courbevoie Cedex
FRANCE

SOLAPAK LTD.
Factory 3, Lock Lane
High Wycombe
U.K.

SOLAMAT INC.
885 Waterman Avenue
East Providence, RI 02914-1383
U.S.A.

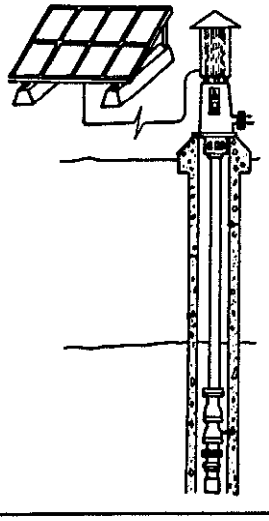
SOLAR POWER CORP.
20 Cabot Road, Woburn
Mass 01801
U.S.A.

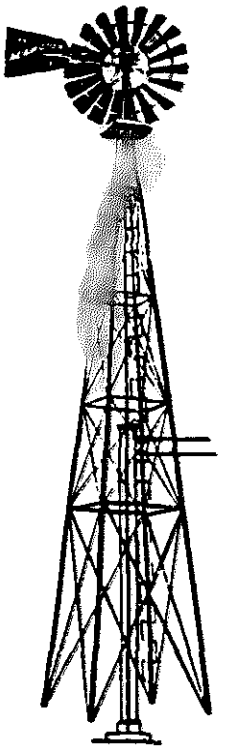
SOLAREX PTY LTD.
5 Bellona Avenue, Regents Park 2143
AUSTRALIA

SOLAR VOLTAICS
A-6020 Innsbruck
Hunold Strasse 3
AUSTRIA

TRISOLAR CORP. INC.
10 de Angelo Drive
Bedford, Mass.
U.S.A.

TPK
149 Bentley Avenue
6-4A Nepean, Ontario
CANADA





WIND-POWERED PUMPS

In general, water pumping windmills have multi-bladed rotors. The reason for this is that a high starting torque is needed to get a water pump started, and the provision of many blades eases starting against a heavy load in light winds. Also multi-bladed rotors run slowly in a given wind which makes this design the natural choice for connecting to reciprocating piston pumps which need to be operated at quite low speeds.

The performance of a windpump is sensitive to the size of pump fitted — fitting a smaller pump will allow the windmill to start in a lower windspeed than a bigger pump. Good judgement is required to fit a pump which will maximise the output from the machine in a given wind regime.

Typical performance figures for a 4.9m diameter windpump are given in the table below.

Wind speed km/h	Head × Output m.m³/h
8	61
16	122
24	183
32	244
40	305

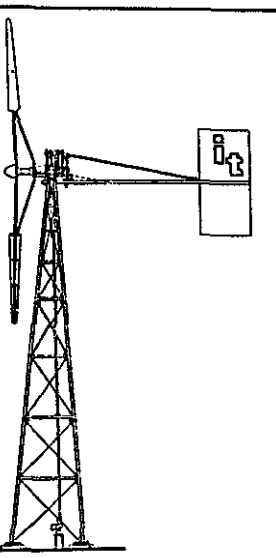
Most machines are designed to make use of windspeeds between 8 and 50km/h. They do not function in lower windspeeds and invariably either furl themselves or deliberately shed a lot of the available power at higher windspeeds with the aid of an automatic governing or furling system to prevent any damage.

The three main uses for windpumps are livestock water supplies, village water supplies and irrigation. Water for the latter is characterized by a large variation in requirements from month to month and in order to satisfy peak demand generally it is only economic to lift from shallow depths. Due to the variability of wind, if a supply of water must be guaranteed, it will be necessary either to provide storage or a standby capability.

MULTI-BLADED WINDPUMPS

The following manufacturers make multi-bladed 'American' type windpumps. An asterisk(*) indicates machines greater than 5m diameter available. The list is adapted from a Technical Brief prepared by IT Power Ltd; it is for general information only and inclusion of any product does not infer that it is specifically recommended.

Illustrated left is a typical example of a multi-bladed windpump. Illustrated right is the Kijito windpump manufactured by Bobs Harries Engineering Ltd. of Kenya.



AERMOTOR
P.O. Box 1364, Conway
Arkansas, 72032
U.S.A.

AGRO-AIDS
27 Shrunagar Shopping Centre
Mahatma Gandhi Road
Bangalore 560 001
INDIA

ALSTHOM ATLANTIQUE*
18320 Jouet sur l'Aubois
FRANCE

ALSTON WINDMILLS PTY. LTD.
Branthorne Street
Gisborne, Victoria
AUSTRALIA

BAKER, THE HELLER ALLER CO. INC.
P.O. Box 29
Corner Perry 7 Oakwood Streets
Napoleon, Ohio 43545
U.S.A.

CLIMAX, WYATT BRO. (WHITCHURCH) LTD.
Wayland Works
Whitchurch, Salop SY13 1RS
U.K.

'COMET', SIDNEY WILLIAMS & CO. LTD.*
P.O. Box 22, Dulwich Hill, NSW 2203
AUSTRALIA

DEMPSTER INDUSTRIES INC.*
P.O. Box 848
Beatrice, Nebraska 68310
U.S.A.

FIASA
Hortiguera 1882, 1406 Buenos Aires
ARGENTINA

S.A. QUILLEMINOT
Place de l'Eglise
10270 Lusigny-sur-Barse
FRANCE

INDUSTRIA METALURGICA
J.A. Sagilo S.A., Buenos Aires
1460 — Bdo De Irigoyen — 1470
ARGENTINA

INST. OF ENGINEERING & RURAL TECHNOLOGY
26 Chatham Lines
Near Prayag Railway Station
Allahabad 211 002
INDIA

'KIJITO', BOBS HARRIES ENG. LTD.*
P.O. Box 40, Daramaini Estate
Thika
KENYA

METTERS M.B.P.(WA) PTY. LTD.
Salvado Road, Wembley, W.A. 6014
AUSTRALIA

MERIN LTD.*
P.O. Box 4145, Karachi 2
PAKISTAN

NEWARK MILLGATE ENGINEERING
Millgate Works, Newark-on-Trent
Nottinghamshire NG24 4XB
UK.

NEYRTEC
BP 61X, 38041 Grenoble Cedex
FRANCE

PARIS WINDMILL
KMP Manufacturing Co. Inc.
P.O. Box 441, Earth, TX 79031
U.S.A.

POLENKO BV
Industrial Terrein
Remmerden 9, 3911 TZ Rhenen
NETHERLANDS

REYMILL STEEL PRODUCTS LTD.
Sta. Rosa, Neuva Ecija
PHILIPPINES

SOUTHERN CROSS, TOOWOOMBA* FOUNDRY PTY LTD.
259 Ruthven Street
Toowoomba, Qld. 4350
AUSTRALIA

SOUTHERN STEEL WORKS LTD.*
Ballyhale, Co. Kilkenny
IRELAND

SUD-AERO
3 rue des Fontaines, 31300 Toulouse
FRANCE

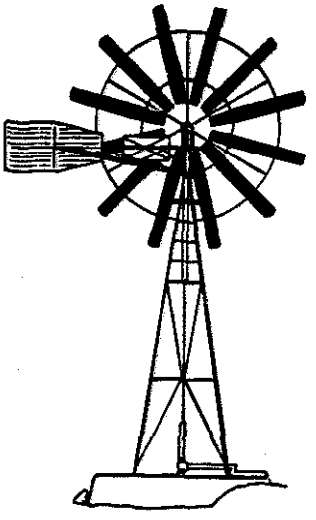
THAI U.S.A. INDUSTRIAL FACTORY
No. 5gl15 M007, 2 Pracharaj
2 Road, Dusit, Bangkok
THAILAND

VITA. VOLUNTEERS IN TECHNICAL ASSISTANCE
6& Soi Area 1, Phaholyothin Road
Bangkok 4
THAILAND

'VOTA' VOLTAS LTD.
Agro-Industrial Division
16 J N Heredia Marg
Ballard Estate, P.O. Box 900
Bombay 400 038
INDIA

WIND BARON CORPORATION*
3702 West Lower Buckeye Road
Phoenix, Arizona 85009
U.S.A.

WIND MACHINES. AUTO SPARE INDUSTRIES
Wind Machines Division
C-7 Industrial Estate
Pondicherry 605 009
INDIA



LIGHT-WEIGHT WINDPUMPS

AMIHAN UTATA
Watt Hydroelectric Systems Inc.
304 J Rizal Street
792717 Mandaluyong, MM
PHILIPPINES

BHARAT HEAVY ELECTRICALS LTD.
Corporate R & D Division
Vikas Nagar, Hyderabad 500 593
INDIA

HAYES (NZ) LTD.
P.O. Box 23-042, Christchurch 4
NEW ZEALAND

HUMBLOT EOLIENNES HUMBLOT
8 Rue d'Alger
Coussey, 88300, Neufchateau
FRANCE

LUBING MASCHINENFABRIK GmbH
2847 Barnstorf, Postfach 110
W. GERMANY

LE MINSTRAL, A BRUNO
Route de Mons, Bonchamps-les-Laval
53210 Argentre
FRANCE

'OASIS', ETS. PONCELET & CIE
BP 1, 10380 Plancy l'Abbaye
FRANCE

ORP/TOOL. LABOUR ORGAN. OF THE RURAL POOR
P20 Green, Park Extension
New Delhi 110 116
INDIA

PUMPOMAT. H. FREES INQ.
Windkraft Zentrale
Lütthöm 51
2330 Eckernförde
W. GERMANY

SPARKO PUMPS
A/J Naesberg, 6800 Varde
DENMARK

TRYLON WINDPUMP
The Wind Turbine Co. of Canada
21 Howard Avenue
Elmira, Ontario N3B 2C9
CANADA

WIND ENERGY UNIT
Water Resources Board
2A Gregory's Avenue, Colombo 7
SRI LANKA

OTHER TYPES

AEROWATT SA
37 Rue de Chanzy, 75011 Paris
FRANCE

BOSMAN, WATERBEHEERSING EN MILIEVERBETERING BV
Steggesdijk 4
Postbus 3518, 3364 Piershil (Z-H)
NETHERLANDS

BOWJON INC.
2829 Burton Avenue
Burbank CA 91504
U.S.A.

CAVENTO, EMPRESA BRASILEIRA DE EQUIPAMENTOS INDUSTRIAIS & AGRICOLAS LTD.
Ce 021, KM06 Maranguape Io Distrito
Industrial do Ceara
BRAZIL

JYOTI LTD.
Energy Division
Tandalja, Vadodara 391 419
INDIA

NORTH WIND POWER INC.
Box 556, Morstown, Vermont 05660
U.S.A.

VARCOE CHAPMAN & SAUNDERS PTY. LTD.
Crouch Street
Mount Gambier, S.A. 5290
AUSTRALIA

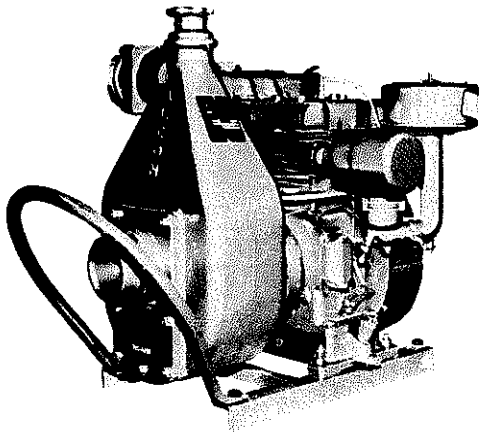
WADLER MANUFACTURING CO. INC.
Route 2, Box 76, Galena
Kansas 66739
U.S.A

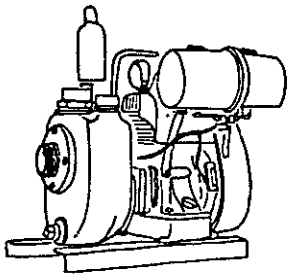
PORTABLE PUMPSETS

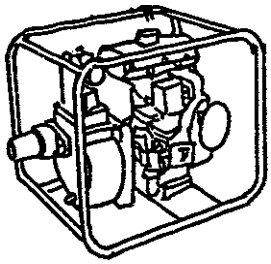
The majority of these consist of a self-priming centrifugal pump driven directly by internal combustion engine. The light-weight models are generally powered by 2- or 4-stroke petrol engines, the larger machines by diesel engine. The smallest pumpsets come fitted with a carrying handle or frame, while the bigger units are usually trolley- or skid-mounted.

'ALCON' MKIII CENTRIFUGAL PUMPSET A model (illustrated right) made of aluminium can be close couped to an electric motor or petrol engine. Capacities up to 30m³/h and maximum heads to 30m. A wide range of skid and trolley-mounted engine and motor-driven pumpsets is also available.

LA BOUR PUMP CO. LTD.
Denington Estate, Wellingborough
Northants. NN8 2QL
U.K.







PORTABLE PUMP UNIT This steel bodied self-priming centrifugal pump, fitted with a pair of carrying handles, is available in two sizes, 51 and 76mm outlet diameter. Connected by belt-drive to a 5hp diesel or optional light-weight petrol engine, they have maximum outputs of approximately 30 and 70m³/h at an operating head of 9m. Weight 120kg.

ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wiltshire SN16 9SG
U.K.

CARPI B40 A self-priming centrifugal pump made of aluminium and close coupled to a 4hp 2-stroke petrol engine. Output 16m³/h at 5m total head or 1.6m³/h at 35m. Maximum suction head 7m.

F.LLI GIACOMO & LUIGI CARPI
42028 Poviglio, Reggio E
ITALY

DAE HEUNG WATER PUMPSET This self-priming 76mm model weighing 35kg is mounted in a tubular carrying frame. Close coupled to a petrol engine, it has a maximum output of 66m³/h; maximum total head 15m. Belt-driven centrifugal pumps also available. Manufactured by Dae Heung Machinery Co. Ltd. and available from:

KOREA TRADE PROMOTION CORPORATION
C.P.O. Box 1621, Seoul
KOREA

DANARM ENGINE PUMPS Model PE 25 weighing 10kg, is a 2hp 2-stroke, 25mm self-priming centrifugal pump set. Typical performance 3.5m³/h at 35m head. Maximum output 6.6m³/h; maximum total head 42m. A 5hp 4-stroke model is also available.

DANARM
Stafford Mill Estate
London Road, Stroud GL5 2BP
U.K.

'EASIPRIME' PUMPS Two basic self-priming 50mm models are available, the 4250 and 4256. They can be close coupled to a choice of power units — petrol, kerosene, and diesel engine or electric motor up to 2.2kW. Typical performance 15m³/h at 18m total head. 80 and 100mm sizes also available skid or trolley-mounted.

LEE HOWL PUMPS
Alexandra Road, Tipton
West Midlands DY4 8TA
U.K.

'TEXMO' SELF-PRIMING PUMPSET Available in two sizes, 51 and 63.5mm, close coupled to Enfield Villiers MK 12 and MK 25 petrol engines respectively. Weights 36 and 56kg.

THE ENFIELD INDIA LTD.
304 & 305 Anna Salai (Mount Road)
Madras 600 018
INDIA

'UNION' SP2 Similar to the Alcon model and powered by 2hp Villiers petrol engine.

SAMUEL, SONS & CO. LTD.
184 Messenger Street, Colombo 12
SRI LANKA

'AUTONOME' GP234 and GP334 Similar to the Carpi design. Driven by 2-stroke petrol engines of 30cc and 47.5cc capacity they have maximum outputs of 9 and 16m³/h respectively.

GRANJA S.A.
S 102 Route de Toulouse
31270 Cugnane
FRANCE

E-ZEE-FLOW SB 1 A cast iron or aluminium self-priming centrifugal pump (with 51mm or 38mm threaded connections) close coupled to a choice of 3hp petrol engine, 3.5hp diesel or 0.75 to 1.5kw 2 pole single or 3-phase electric motor. Typical performance 12m³/h at 15m total head. Maximum suction lift 7.6m.

DUNWELL PRODUCTS
P.O. Box 8543
Belmont, Bulawayo
ZIMBABWE

TROLLEY-MOUNTED PUMPSETS

These units typically consist of a centrifugal pump connected directly to a petrol or diesel engine and mounted on a two-wheel trolley or trailer for easy transport. Occasionally they may be driven by electric motor. An example is illustrated on the right.

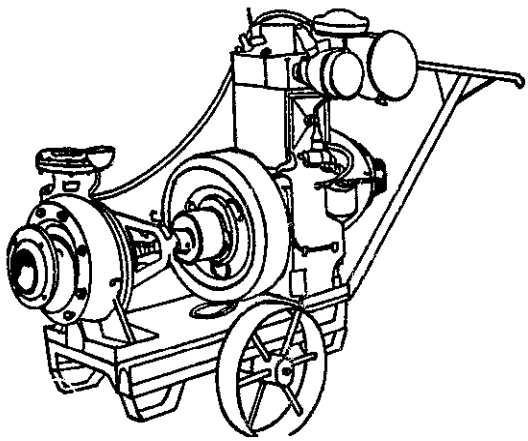
'GOLDEN JET' PUMPSETS Two self-priming models, the 2372 and 2318 are driven by an 84cc 2-stroke and a 4-stroke petrol engine respectively. Maximum outputs 17.5 and 13m³/h. Small electric motor-driven pumps are also available.

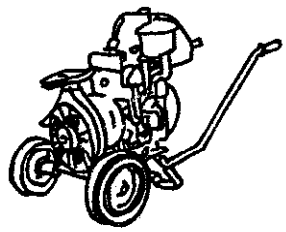
R.C.M.
32 Cours de Verdun, 38200 Vienne
FRANCE

HMC URGENT This special design consists of a combined hand-operated diaphragm pump and a propellor-type 500mm centrifugal pump. Four models are available fitted with either petrol engine or electric motor. Maximum suction lift 3m; maximum delivery 5m. Capacities from 7 to 24m³/h.

HOMECO B.V.
6950 AB Dieren
NETHERLANDS

ITTEFAQ MOBILE DIESEL PUMPSETS Model DE-7, similar to illustration, is driven by a 9.2hp single cylinder engine and is available in three sizes: 65, 75 and 100mm (pump outlet diameter). Total head ranges from 9 to 18m with corresponding outputs from 144 to 40m³/h. Weight 166kg. Larger twin-cylinder model, DE-14 has approximately double the capacity.





ITTEFAQ FOUNDRIES LTD.
32 Empress Road, Lahore
PAKISTAN

RENSON PORTABLE PUMPS Series CEL-CES-CDI consists of a self-priming centrifugal pump with a choice of coupling to electric motor, petrol or diesel engine. Motor sizes 2, 2.5 or 3hp. Maximum output 30m³/h. Portable hand carried model also available.

ETS RENSON & CIE. S.A.
BP23
59550 Landrecies
FRANCE

RUGGERINI PORTABLE PUMP UNITS A wide range of trolley- and trailer-mounted engine driven centrifugal pumps are available. Eleven self-priming models are fitted with 5.5hp petrol or 6.5 to 17.5hp diesel engines — including three slow speed versions. Outputs from 12 to 200m³/h for total heads of 30 to 8m respectively. Over forty other models in the 2.5 to 30hp range are available. (illustrated below left).

RUGGERINI MOTORI
42040 Villa Bagno, Reggio Emilia
ITALY

'SALMSON' PUMPS A range of self-priming pumps is available driven by a choice of petrol, diesel engine, or electric motor. Capacities from 4 to 140m³/h. Maximum suction lift 7.5m; total head 46m.

SOCIÉTÉ ELECTRO-HYDRAULIQUE
157 Bureaux de la Colline
92213 St. Cloud Cedex
FRANCE

'SUJALA' DIESEL PUMPSET Similar to the example illustrated this centrifugal pump with 63.5mm outlet is coupled directly to a 5hp single cylinder water-cooled 4-stroke high-speed diesel engine. Minimum rated output 55m³/h at 12m head.

WEST BENGAL AGRO-INDUSTRIES CORP. LTD.
25 B Netaji Subhas Road
Calcutta 700 001
INDIA

'TOBATTA' DIESEL PUMPSETS Eight models are available driven directly by diesel engines of 4.5 to 16hp. The centrifugal pumps vary in size from 51 to 152mm with outputs of 7 to 23m³/h at 32 and 24m operating heads; and 130 to 240m³/h at 15 and 5m heads. Weight of the smallest set is 146kg and the largest, 388kg.

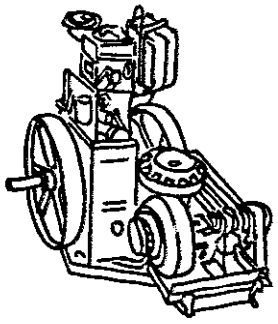
KUBOTA TEKKO DO BRASIL INDÚSTRIA E COMÉRCIO LTDA.
Av. Fagundes de Oliveira 900
CEP 09900, Diadema SP
BRAZIL

STATIONARY PUMPSETS

These pumpsets are generally larger than the portable models and are invariably powered by diesel engines or electric motors connected directly in-line or by belt drive. A choice of engine and pump type combined with a wide range of sizes enables most requirements to be met. They are usually mounted on a base-plate, pedestal or bed-frame ready for bolting down. In some cases trolley or trailer options may be available.

EICHER DIESEL PUMPSETS A range of high and low speed vertical water-cooled diesel engines from 5 to 20hp driving end-suction split casings or volute-type centrifugal pumps is available. Method of coupling is by direct in-line drive, similar to the model illustrated right, or by belt drive as shown below. Total head range from 4 to 14m with corresponding outputs from 180 to 75m³/h.

EICHER GOODEARTH LTD.
Deepak 3rd Floor, 13 Nehru Place
New Delhi 110 019
INDIA



VIJAY PUMPSETS These consist of a vertical water cooled single-cylinder diesel engine from 5 to 10hp coupled either directly or by belt drive to a variety of centrifugal pumps — self priming, end-suction, split casing and volute types, shown right. Total head range from 6 to 26m with outputs from 135 to 36m³/h respectively. Electric motor driven options also available.

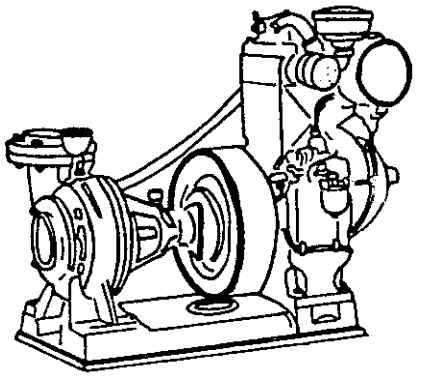
NEW VIJAY INDUSTRIES LTD.
P.O. Willingdon College
Vishrambag, Sangli 416 415
Maharashtra
INDIA

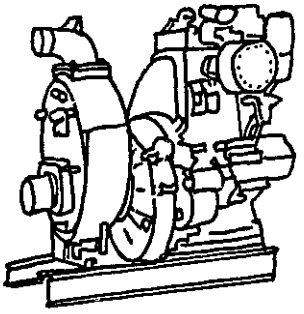
KIRLOSKAR PUMPSETS A range of diesel engine and electric motor driven centrifugal pumpsets are available. The engines of the vertical water cooled single-cylinder variety 5 to 8.7hp, are connected directly to end-suction type pumps suitable for total heads from 6 to 26m with corresponding outputs from 120 to 36m³/h. The electric motor pumpsets are capable of twice this performance.

KIRLOSKAR BROTHERS LTD.
Udyog Bhavan, Tilak Road
Pune 411 002
INDIA

KRISHI DIESEL PUMPSETS Two vertical 4-stroke water cooled single cylinder models available with rated outputs of 5 and 6.5hp at 1500rpm. Coupled directly to 75 × 62.5mm or 100 × 100mm split-casing centrifugal pumps for heads from 6 to 18m with corresponding output 84 to 26m³/h. Similar performance trolley-mounted horizontal engine version also available with direct or belt drive.

KRISHI ENGINES LTD.
A-7 Unit Sanatnagar
Hyderabad 500 018 A.P.
INDIA





CENTRIFUGAL PUMPS

A wide range of equipment is available including Series T and MT self-priming end suction centrifugal pumps. Manufactured in sizes from 40 to 200mm they can be supplied as engine or electric motor-driven pumpsets or alternatively as bare shaft pumps. Engine sets are available on fabricated steel bases for stationary mounting or on heavy-duty site trolleys or highway trailers for transportation. The 40 and 50mm petrol engine-driven versions can also be supplied as portable pumpsets fitted with a carrying handle. Motors and engines for the T and MT Series vary in size from 1 to 3hp for the smallest to 20 to 41.5hp for the largest. A 76mm stationary engine set is illustrated left. Maximum suction lift 7.6m. Maximum total delivery head from 12 to 30m. Maximum ouput from 2 to 360m³/h.

H.J. GODWIN LTD.
Quenington, Cirencester
Glos. GL7 5BY
U.K.

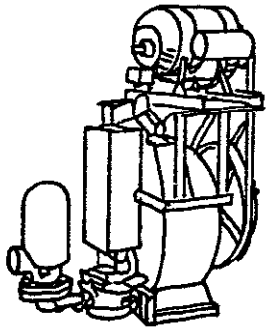
ENGINE- AND MOTOR-DRIVEN DEEP WELL AND BOREHOLE PUMPS

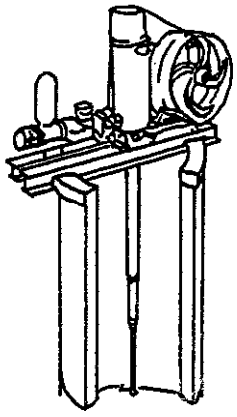
GODWIN 'K' PUMPS This series of deep well reciprocating piston lift and force pumps fitted with a geared powerhead which can be driven by engine or electric motor connected directly or by belt drive. The KBE self-contained electric motor-driven model is shown above. Four sizes available with choice of cylinders from 44.5 to 171.5mm and motors from 0.75 to 9hp. Maximum total heads up to 150m with outputs from 0.75 to 21m³/h.

H.J. GODWIN LTD.
Quenington, Cirencester
Glos. GL7 5BY
U.K.

CIECO DEEP WELL POWER PUMP Similar to the above pump, this model is designed for heavy-duty deep well use.

CENTRAL INDIA ENGINEERING CO.
2153/5 Hill Street, Ranigunj
Secunderabad, 500 003 A.P.
INDIA



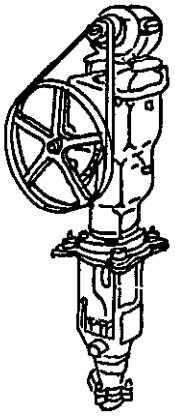


'SIRIUS' DEEP WELL PUMP The electric motor-driven deep well lift and force pump, illustrated right, is suitable for lifts of up to 50m or more and for forcing up to 80m. Five cylinder sizes available, from 60 to 120mm with outputs from 0.6 to 4m³/h.

BRIAU SA
B.P. 43
37009 Tours Cedex
FRANCE

'CLIMAX' POWER PUMPING SETS These geared powerhead pumps are belt-driven by engine or electric motors of 0.75 to 8.5hp. 'No. 28' model shown left is available with cylinder sizes up to 172mm and stroke length up to 600mm. Maximum total head 122m; output from 0.36 to 19m³/h.

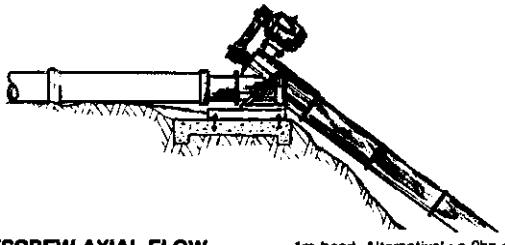
BARNABY CLIMAX
White Ladies Close
Little London, Worcester WR1 1PZ
U.K.



JYOTI VERTICAL TURBINE PUMPS

These high capacity electric motor-driven line shaft deep well centrifugal pumps are available in a range of sizes suitable for boreholes from 100 to 750mm diameter and maximum heads up to 100m.

JYOTI LTD.
Bombay Shopping Centre
R.C. Dutt Road, Vadodara 390 005
INDIA

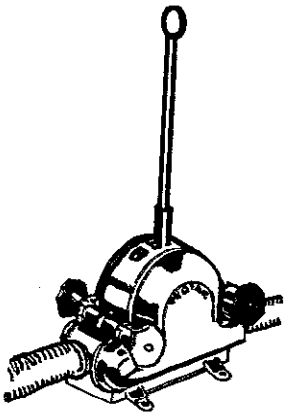


BATESCREW AXIAL FLOW PUMPS

These low-lift high discharge pumps can be powered by electric motor, diesel or petrol engine connected directly or by belt-drive. They consist of a shaft-driven axial flow impeller mounted at the lower end of the discharge pipe. Installation can be either vertical or at an angle as illustrated. Available in a range of sizes, the smallest powered by a 3hp motor has a capacity of approximately 300m³/h at 1m head. Alternatively a 9hp model can deliver 330m³/h at a total head of 4.6m or 950m³/h at 1m.

Portable 3.5 and 5hp models also available driven by 2-stroke and 4-stroke petrol engines. Typical performance 120m³/h at 1m.

BATESCREW ENGINEERING PTY. LTD.
Denilliquin Street
Tocumwal N.S.W. 2714
AUSTRALIA



DIAPHRAGM HANDPUMPS

The self priming pumps are particularly useful for moving water containing suspended solids. Generally small and light-weight, they can be supplied with flexible suction and delivery hoses for transportation. Double-acting models — an example is shown left — have twin diaphragms usually made of nitrite or butyl rubber and are easily accessible when replacement becomes necessary. Maximum suction lift is normally between 4 and 7m, delivery head from 2 to 5m, and output from 60 to 140 litres/min. Typical applications are: dewatering on construction sites; bilge and barrel emptying; and drinking water supplies.

The following make a range of both single and double-acting diaphragm handpumps.

PUMPENFABRIK BEYER
Dorfstraße 25, Ot Wulfsfelde
2361 Pronstorf
W. GERMANY

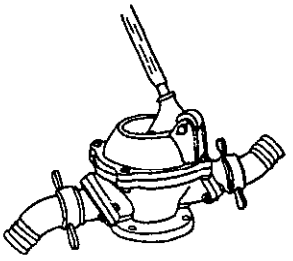
PATAY PUMPS LTD.
The Ridgeway, Iver, Bucks.
U.K.

MUNSTER SIMMS ENGINEERING LTD.
Old Belfast Road, Bangor
N. Ireland
U.K.

Heavier duty hand-operated diaphragm pumps designed for agricultural purposes and capable of delivery heads of up to 12m have outputs from 80 to 120 litres/min. Illustrated right, these can also be trolley mounted for easier transportation.

POMPES GRILLOT
Rue de l'Observance
B.P. 118, 84007 Avignon
FRANCE

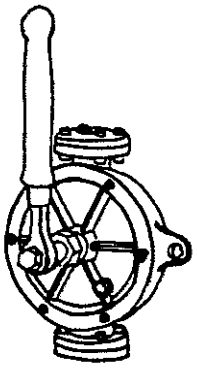
RENSON ET CIE
BP 23, 59550 Landrecies
FRANCE



'CONTRACTOR'S' DIAPHRAGM PUMPS

Model No. 2745 is a lift-only pump suitable for raising large quantities of water containing sand, grit or sewage. Four sizes available with optional double actuating hand levers. Capacities from 90 to 450 litres/min. Lift and force model No. 2746 also available.

HATTERSLEY NEWMAN HENDER LTD.
Burscough Road, Ormskirk
Lancashire L39 2XG
U.K.



SEMI-ROTARY HANDPUMPS

This type of double-acting pump which is illustrated right, is commonly used for lifting small quantities of liquid and delivering it to a higher elevation. Typical applications are the filling of an overhead water tank from a lower source or the transfer of liquid fuels and oils from storage tank or barrel. The pump — sometimes known as a 'wing' pump — is operated by moving the handle from side to side in an arc of approximately 90 degrees. The cast iron body of the pump houses the semi-rotary pump mechanism which is fitted with brass or gun-metal flap valves.

Commonly available sizes are from 12.5 to 38mm (suction and delivery pipe diameters); up to 76mm occasionally available. Maximum suction lifts generally between 3 and 5m, delivery head 5 to 10m, and capacities from 15 to 150 litres/min. The fitting of non-return valves is sometimes suggested for the higher head installations.

A range of sizes are available from the following manufacturers:

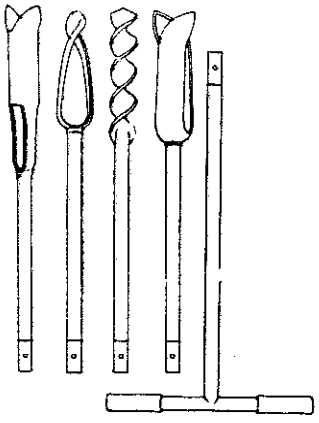
PUMPENFABRIK BEYER
Dorfstraße 25, Ot Wulfsfelde
2361 Pronstorf
W. GERMANY

CENTRAL INDIA ENGINEERING CO.
2153/5 Hill Street, Ranigunj
Secunderabad 500 003 A.P.
INDIA

FABRICA DE IMPLEMENTOS AGRICOLAS (FIASA)
Hortiguera 1862, 1406 Buenos Aires
ARGENTINA

POMPES GRILLOT
Rue de l'Observance
B.P. 118, 84007 Avignon
FRANCE

RENSON ET CIE
BP 23, 59550 Landrecies
FRANCE



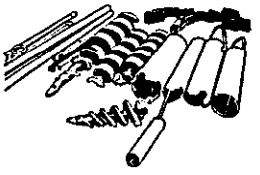
SOIL SURVEYING AND DRILLING

The following type of equipment is available from this manufacturer for soil research and shallow wells and latrine construction, and surveying. They also supply a range of instruments for hydrogeological, meteorological and agricultural research.

HAND AUGERS A full range of augers is available for investigations up to 7m in depth. An example is illustrated left.

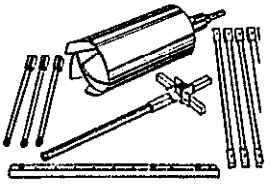
BAILER BORING EQUIPMENT Tripods, winches and bailer boring rig for performing augerings down to 15m. Not for use in hard or stony soils. Use of steel casings allows depths of 25m to be reached.

MOTORIZED SOIL AUGER This machine can be used for general soil research and for drilling holes for posts, tree planting or vertical drainage. Uses half-flighted augers of 50 to 500mm diameter.



SHALLOW WELLS SURVEY SET Hand-operated auger set for determining the presence of water in the subsoil in order to assist choice of potential well sites. Suitable for investigations up to 20m.

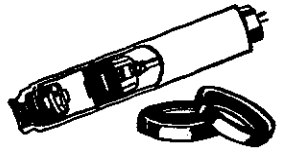
SHALLOW WELLS CONSTRUCTION SET Light and heavy (shown above) hand-drilling sets available for use in soils without very hard layers and with sufficient aquifer recharge to permit small-diameter wells. Standard set equipped with 165 × 150mm casing; heavy set with 220 × 200mm. Maximum depth approximately 20m.



LATRINE DRILLING SET Shown above, the light set can be used to make holes of 250mm diameter and up to 10m deep for sanitation purposes. Heavy set available for 400mm holes.

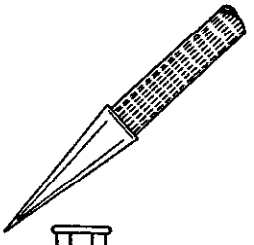
SURVEYING INSTRUMENTS: including Abney levels, clinometers.

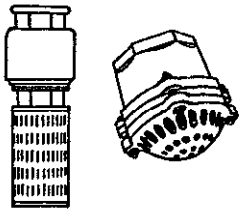
EIJKELKAMP
Equipment for Soil Research B.V.
Nijverheidsstraat 14
6987 EM Giesbeek
NETHERLANDS



PUMP ACCESSORIES

Most manufacturers should be able to supply spares for their particular pump models. Usually these will be the wearing parts such as cup washers for reciprocating piston pumps, shown below, and other valve components. Some will also provide individual pump parts such as the pump cylinder assembly shown above, cylinder cap gaskets, spool and ball valves, or the basic pump stand.





WELL POINTS

Under favourable soil conditions well points (above left) can be driven into the ground on the end of a length of piping and a pump attached for extracting ground-water. The point is usually made from heavy-duty solid cast iron or forged steel and the strainer through which water enters the perforated pipe section during pumping is made from brass.

FOOTVALVES AND STRAINERS

Fitted at the base of rising mains and pump inlets these are usually designed to be non-clogging or self-cleaning. They are typically made from cast iron with bronze internal parts. Illustrated below left. Available from the following manufacturers, the first three of which also supply well points:

PUMPENFABRIK BEYER
Dorfstraße 25, Ot Wulfsfelde
2361 Pronstorf
W. GERMANY

CENTRAL INDIA ENGINEERING CO.
2153/5 Hill Street, Ranigunj
Secunderabad 500 003 A.P.
INDIA

CUMBERLAND GENERAL STORE
Rt. 3 Box 479, Crossville
TN 38555
U.S.A.

BARNABY CLIMAX
White Ladies Close
Little London, Worcester WR1 1PZ
U.K.

DUNWELL PRODUCTS
P.O. Box 8543, Belmont
Bulawayo
ZIMBABWE

HATTERSLEY NEWMAN HENDER LTD.
Burscough Road, Ormskirk
Lancashire L39 2XG
U.K.

KUMAR INDUSTRIES
Edathara Post 678 611, Palghat District
Kerala
INDIA

7. HARVESTING AND THRESHING

OXFAM

Harvesting a peasant's smallholding in Peru.

The crop harvesting equipment available to small farmers in the developing countries has changed very little over the years. Knives, sickles and scythes continue to be the traditional tools used to harvest crops. Some low-horsepower reapers are being developed, but because of their low field capacity, high cost and other problems, they are often not considered a suitable alternative to the manual methods. On the other hand, a large number of efficient, low-cost hand, foot or power-driven threshers have been developed for use on small farms around the world.

The search for more efficient, cost-effective ways of harvesting and threshing crops is important because of the extreme labour intensity of these tasks. For example, in developing countries, up to 40 per cent of the total labour required to grow a crop is expended in the harvesting and threshing operations. At peak harvest periods labour shortages often occur, even in regions that normally have surplus labour, and this can lead to higher costs of production or reduced yields (because of the delayed harvesting). It should be remembered, however, that the introduction of new equipment can mean the loss of local employment opportunities.

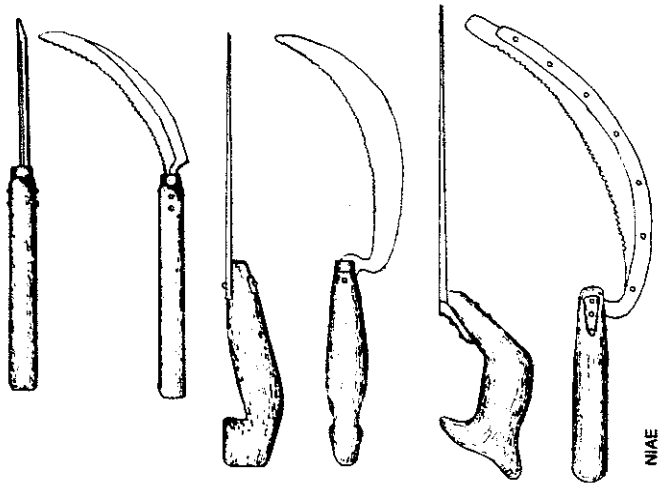
TECHNICAL CHARACTERISTICS

Harvesting equipment

There are three main types of harvesting equipment: manual, animal-powered, and engine-powered.

Manual

A variety of knives, sickles, scythes and reaping hooks are still the principal tools used by small farmers in the developing countries. They are used to harvest the entire



Traditional sickles.

plant or, if necessary, can be used selectively to remove mature plants or seed heads in crops that are not uniformly ripe. The cost of such tools is minimal, they are easily maintained or repaired, and they are familiar and dependable. Manual harvesting is, of course, very labour-intensive and in many situations is an important means of providing work to landless labourers who would otherwise be unemployed.

As harvesters, and in particular threshers, are often paid a percentage of the crop, the value of the wage to the recipient is considerably higher than the cost to the farmer, and may be the labourers' main source of food for the coming year.

Knives A variety of knives are used for cutting plant stalks or grain heads of crops like millet, sorghum and rice. Losses from crop shattering are lower when knife blades are used but labour requirements are very high — about 75 per cent above sickle harvesting. One of the main advantages comes at the threshing stage: selective cutting reduces the moisture content and extra green matter, allowing for safer storage and easier transport.

Sickles A wide range of sickles is used to harvest the majority of cereals and pulses in developing countries. Basically they consist of a metal blade, usually curved, attached to a wooden handle. The degree of curvature and length of blade, the angle of attachment, and the shape of the handle all vary from area to area. The labour requirements for the sickle harvesting vary according to the yield, variety, and moisture content of the straw, and the operators' ability, etc. but are likely to be in the range of 100 to 175 man-hours per hectare. The advantages of harvesting with sickles tend to be greatest with heavy crops.

Scythes A scythe is a curved blade, usually 70 to 100cm long connected to a long shaft which has two handles. The blade is linked to the shaft in various ways, some allowing adjustment of the angle between the two for different crop conditions: the greater the angle the more material is cut at each stroke (and the more arduous the operation). Scythes are efficient harvesting tools, but require considerable skill to use properly.

For cereal harvesting a cradle attachment collects the cut crop and allows it to be deposited at the end of the stroke. The most common arrangement is a group of four or five wooden fingers parallel to the blade. Paddy is not normally scythed as rice straw is both softer and tougher than wheat straw and more prone to lodging. However, in a good stand of wheat, scything can reduce the labour to between ⅓ and ¼ of that needed for sickle harvesting.

Reaping hooks The reaping hook is a compromise between a sickle and scythe. It is short handled and has to be used in a crouching position, but the sharp blade will cut the crop without having to hold it. Reaping hooks are frequently used with hooked sticks to gather the crop as it is cut.

Animal-powered

Animal-powered harvesters are relatively rare in developing countries. Ox-drawn reapers, based upon designs of machines used with horses, have been tried in India but are not used widely. The limited draught available from ox-pairs, the problems of harvesting lodged crops and the cost of the machines compared to tractor-drawn harvesters, have limited the commercial development of such harvesters.

Engine-powered

A number of prototype reapers and reaper-binders have been designed to meet the harvesting needs in developing countries. In the case of binders, the high cost of twine (estimated at $15/ha) has made certain machines uneconomic. Other harvesters, because of low field capacity, high cost or other problems have, on the whole, been found unsuitable. However, a Chinese vertical conveyor reaper promoted by IRRI is proving to be an efficient mechanical harvester of crops under conditions existing in developing countries.

Threshing equipment

Threshing equipment involves three quite distinct operations:
— separating the grain from the panicle
— sorting the grain from the straw
— winnowing the chaff from the grain.
The first of these requires considerable energy and is the first to be mechanized. Sorting the grain from the straw is relatively easy but is the most difficult stage to mechanize. Winnowing is relatively easy, whether by machine or by hand.

Manual threshing

Most manual threshing methods use some implement to separate the grain from the ears and straw. The simplest

Traditional threshing equipment: a box with threshing bars placed over it and (inset) a flail.

method is a stick or hinged flail with which the crop, spread on the floor, is beaten repeatedly. Such tools are simple and cheap, but they are also slow and exhausting to operate. Rice is usually threshed by beating bunches of panicles against the ground, a stone, a bamboo frame, or the edge of a tub or basket. A screen usually surrounds the threshing area to avoid grain loss. Output per man-hour varies considerably, but is generally between 25 and 50 man-hours per tonne.

Slightly more complex mechanical threshers and shellers are available which still rely only on human power. Treadle-operated threshers, consisting of a drum with rows of wire teeth which is rotated by pedalling a treadle, are commonly used for rice. Output is typically 100-150kg per hour for one-man machines. Such threshers are relatively cheap, light and easily manufactured locally. Because of the higher power requirement, these machines are not suitable for threshing wheat.

Maize shellers consist of a feeder funnel and a shelling disc which is rotated by a hand-crank. The grain is removed as the cob moves down through the machine; output is 100-150kg per hour. Work rates of 750-900kg per hour are claimed for a pedal-operated maize sheller which has a fan to separate light trash from the grain. At an even simpler level are low-cost hand-held maize shellers. These have low work rates but save wear and tear on the hands.

Animal-powered threshing

Animal trampling remains the standard method of threshing grain crops in many parts of the world. While slow, and often resulting in impurities and damage to the grain, it makes threshing less arduous and can be cheap if oxen or buffaloes are readily available. Productivity, at 30-50 man-hours per tonne, is about the same as for manual methods. The animals may pull a heavy object or implement behind them, such as a stone roller, sledge or disc harrows, to increase the rate of work.

Engine-powered threshing

Tractor-treading One method of threshing which has become widespread for rice, wheat, barley and sorghum is driving a tractor round and round on the crop spread over the threshing floor. If tyre pressure is kept low to minimize grain damage, excellent results are possible, and no added investment in machinery is required.

Hold-on threshers In areas where whole, undamaged straw is valued, some machines thresh rice by stripping grain from the panicles without damaging the straw. The simplest of these are mechanized versions of the treadle thresher in which the drum is rotated by a 1-3hp engine. Double drum threshers contain two-wire looped cylinders. Most threshing is done in the slower, first cylinder which strips the grain on the panicles from the straw. The second, faster, cylinder is designed to thresh the broken panicles. Double drum threshers are used for wheat and sorghum as well as paddy. Some have a self-feeding mechanism which continuously feeds the bundles into the machine, thus reducing the labour requirement.

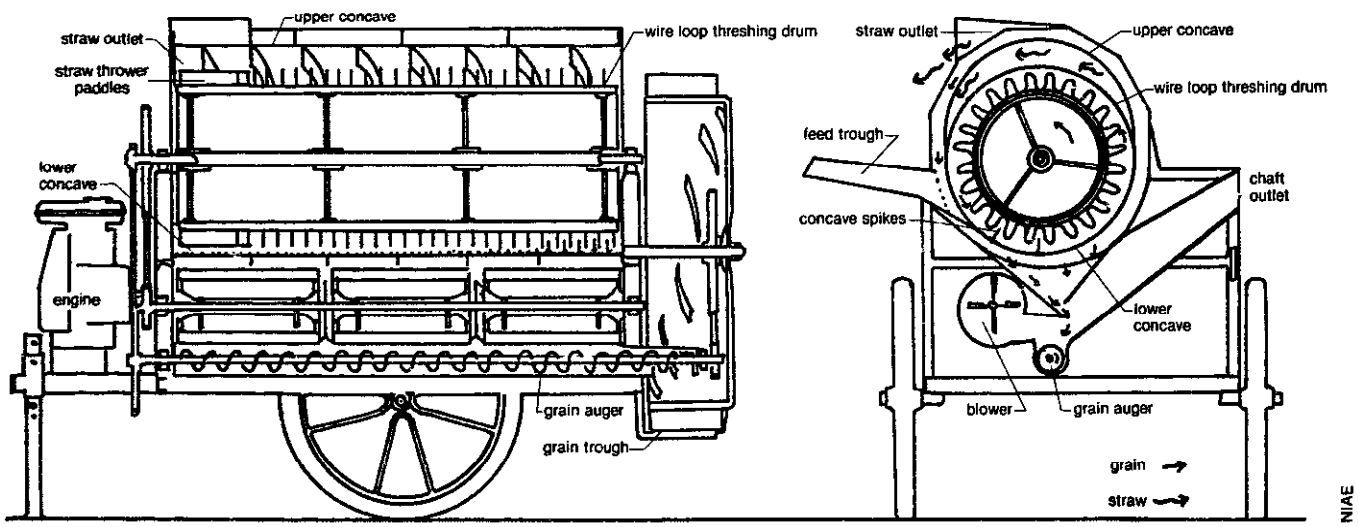
Hold-on threshers require that the crop be formed up into even bundles, and this can be laborious if the crop was badly lodged or if even bundles were not harvested in the first place. Their main advantage is that they solve the major problem of all other threshers — how to separate the grain from the straw.

Through-flow threshers The entire harvested crop is fed into this type of thresher, thus increasing the bulk which has to pass through the machine. Faster feeding is possible but higher power requirements are inevitable. There are two main types:

- Tangential flow machines in which the crop passes directly through the threshing cylinder, around the circumference of the drum.
- Axial flow machines which have spirally positioned fins on the upper concave so that material fed in at one end of the drum passes along the drum as it is rotated, and is ejected at the other end.

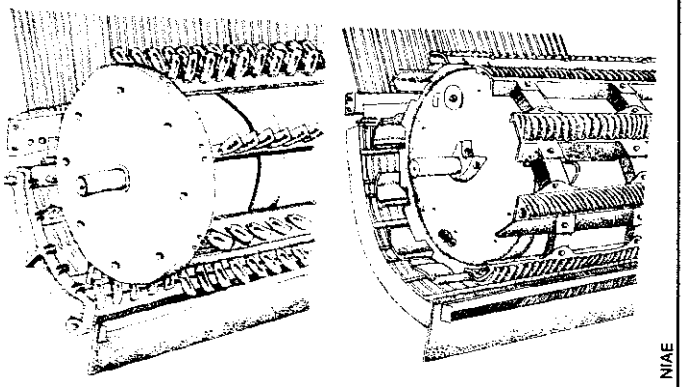
In both machines the threshing occurs as the crop passes between a revolving cylinder and a metal grate called the concave, which covers part of the circumference of the drum. Threshed grain falls through the holes in the concave. The mechanism which causes the beating/rubbing which separates grain from straw and chaff can be of several types: wire loop, spike (or peg) tooth, rasp bar, angle bar.

Power for engine-driven threshers may be from a small engine mounted on the machine (2 or 3hp upwards), or from a tractor. Most machines allow adjustments for



Schematic drawing of an axial flow thresher.

various crop and field conditions, and a large selection is available with varying drum, power supply and winnowing/cleaning arrangements. The simplest consist of little more than the threshing cylinder and concave mounted on a metal framework including feeding chute, outlets and a suitable engine.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Threshing mechanisms: peg-tooth drum and slotted metal concave (left); Rasp bar and wire concave (right).

More complex threshers which include winnowing fans and sieves to separate grain from straw and chaff include the axial flow thresher developed by IRRI in the Philippines which has been widely adopted by rice producers. Also, the Alvan Blanch Minor thresher from the UK performs successfully with wheat, barley and sorghum; and various Indian-manufactured threshers are used primarily for wheat threshing. They are capable of very high outputs (0.5 to 2 or more tonnes per hour) and remove the need for hand winnowing, but are considerably more expensive and more difficult to repair in rural areas. They are more suitable for contractor operators than individual farmers in developing countries.

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Engine-powered threshing in Bolivia.

Maize shellers Engine-powered maize shellers operate similarly to the threshers, with rotating cylinders of the peg or bar type and metal concaves. Cobs must be husked before entering the threshing drum. Some maize shellers have husking rollers which husk the cobs before they are passed to the threshing drum. As with other grain threshers, cleaning fans may be included which remove any trash from the grain. Shellers may have their own engine or be driven from a tractor pto, and range in size from 1hp models with 100kg/hr capacity to pto-driven models with a capacity of several tonnes/hr.

Separating grain from straw

The simplest way to separate grain from straw is to pick the straw up and shake it, letting the grain fall out. A better method is to use a pitchfork to do the shaking. The earliest mechanical sorters emulated the pitch fork, and this type consists of three or five troughs mounted on cranks in such a way that the straw is picked up and thrown forward by each trough in turn. This is a very simple and reliable mechanism, but it is also very bulky.

With a well-designed threshing drum, roughly 80 per cent of the grain should be sorted in the drum by passing through holes in the concave. Recent developments with axial flow threshers have increased this to 100 per cent so that a thresher can do without the very bulky straw walkers. One feature of the axial flow drum is that sorting is more effective at high loadings, whereas the efficiency of straw walkers falls off very rapidly as the throughput rises. For hand-fed machines, where feeding tends to be erratic, the straw walker is probably the most efficient.

Winnowing

Traditional threshing methods leave a lot of trash among the grain and separating this can require almost as much labour as the original threshing. If there is plenty of wind, the threshed material is tossed in the air using forks, shovels, baskets, etc. (see Section 9 for information on hand tools for materials handling) and the lighter chaff and straw is blown to one side while the grain falls vertically. Final cleaning may be done with a winnowing basket, which is shaken until any chaff and dirt separate at the upper edge. This is very simple and effective but, at only about 40-45kg per hour, it is slow. An alternative is to use winnowing sieves, open weave baskets that may be suspended on tripods. They are shaken so that the grain falls through; the chaff and straw remain in the sieve.

Various types of winnowing machines are designed to create artificial wind. The simplest are hand- and pedal-operated fans: two, three or four light metal blades are rotated by hand cranks or foot pedals. Slightly more sophisticated is the fanning mill, where the fan is mounted in a wooden housing which contains sieves and screens — the grain is thus graded as well as cleaned. The fan may be manually or engine powered. Fanning mills produce a very clean sample but cannot cope with large amounts of straw, so they are more appropriate for finer winnowing. Details of further cleaners, used primarily for crop-processing operations, are to be found in Section 8.

Advantages

Potential advantages of harvesting and threshing equipment include:

- eliminating the labour bottlenecks at peak periods;
- increased yields due to timely cultivation for next crop;

Mechanical harvesting and threshing of crops becomes most advantageous where improved farming practices such as the use of high-yielding varieties, multiple cropping systems and expanded use of irrigation water are introduced. With such systems large quantities of crops mature and need to be harvested at one time, the time for preparation of the land and re-planting of successive crops can be short and, often,

labour for manual harvesting is not available during the peak times when it is needed. With higher yields from better production technology, the relative benefits of mechanical over manual harvesting are increased.

Alternatives

Combined harvester threshers (combines) are the norm for large-scale farms, but they cannot easily be reduced in size and complexity for small farmers. Some work is being done on simple wholecrop harvesters where the crop is cut, and either chopped into short (20-50mm) lengths that in effect threshes it, or else the straw is bruised and broken by drums to give a material which can be used as animal feed. The other approach that shows some hope for the small farmer is the stripper harvester that separates the grain from the ears without cutting the straw. This makes for a very cheap, simple machine.

COSTS AND BENEFITS

Indicative costs

The cost of harvesting and threshing is normally expressed as cost per hectare of crop or as cost per tonne of grain produced i.e. it can be calculated on either an area or weight basis. The total operating cost per hectare is the sum of the total fixed cost of the machine, namely interest, depreciation, tax and repairs and total variable cost which comprises the cost of unskilled and skilled labour, fuel, oil, lubricants. In the case of binders, the cost of binding twine is added to the variable cost.

In the following table, indicative figures are given for the capital costs of a variety of mechanical harvesting devices.

Type		*Capital Cost ($)*
Mometora Reaper (5hp)	Reaper	693
	Power Tiller	1386
TNAU Reaper (10hp)	Reaper	590
	Power tiller	2250
Satoh Reaper (5.4hp)	Self-propelled machine	1400
Vertical Conveyor Reaper (8hp)	Reaper	1000
	Power Tiller	1750

Source: RNAM (1983)

Economics and scale

Several factors other than capital costs affect decisions on using harvesting and threshing equipment. The size of the farm in physical and economic terms influences the scale of machinery and the size of investment that is appropriate. If only a small amount of work is undertaken each season, then the capital costs per unit of work done may be so high that a machine is uneconomic compared to alternative methods. This can be avoided where multi-farm use is possible, but this use requires a high degree of organization and co-operation, especially where timeliness is critical.

Small and irregularly shaped fields result in low field efficiency of engine-powered or even animal-drawn machines. Poor access increases the time needed to get to the fields, and lack of access roads sometimes

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Manual harvesting provides paid employment to some of the poorest members of society.

excludes engine-powered machines altogether. Where terraced cultivation is practised, all tools may have to be light enough to be carried on a person's back.

Traditional cropping systems may exclude or make difficult certain types of harvesting technology. Mixed cropping makes mechanized harvesting difficult. Growing a mixture of varieties of single crop can have the same effect e.g. mixed millet varieties may not all thresh well at a single concave setting and drum speed. Poor land clearing leaving stumps and rocks in the field may prevent the use of animal-drawn and engine-powered implements. Similarly, broadcast or randomly transplanted rice crops cannot always be harvested by machines which rely on crops being grown in rows. These are all factors which must be taken into consideration when deciding to invest in a particular piece of equipment.

Bearing these factors in mind, an example is given of how the cost of harvesting with a 5hp Mometora reaper was worked out in various countries (see page 120).

These costs can be compared with costs of manual harvesting as follows:

		India (rice)	*Indonesia (rice)*	*Pakistan (wheat)*	*Philippines (rice)*	*Thailand (rice)*
Total cost per hectare	$	28	29	31.25	65.76	59
Total cost per tonne	$	7	7.25	7.81	16.44	14.75

Health and safety

Much harvesting and threshing equipment is potentially dangerous if not manufactured to an adequate standard or not used properly. Costs of locally manufactured equipment are sometimes kept low by omitting safety features. In India, for example, small town artisans are producing threshers without the protective guard needed to take wheat into the machine and keep hands and arms out. This saves sheet metal but raises accident rates — 95 per cent of which occur while crops are being fed into the machines. With the numbers of new machines increasing by 50,000 per annum, the accident rates during threshing are also rising — from 500 in 1975 to 5000 in 1980.

Fixed and operating costs of harvesting with a 5 hp Mometora. (RNAM 1983.)

A. Fixed Cost ($)

	Reaper	Power Tiller
1. Purchase Cost (p) ($)	693	1386
2. Fixed cost* per hour ($ per hour)		
a) Depreciation	0.30	0.16
b) Interest (12%)	0.15	0.09
c) Repair (8% of purchase price)	0.18	0.11
d) Tax, insurance, housing (2% of purchase price)	0.05	0.03
Fixed cost per hour	0.68	0.39
3. Total fixed cost (for reaper and power tiller per hour)	1.07	

* Assumes 2100 hours and 7 years of life for harvester and 8000 hours and 8 years life for mounting tractor.

Social impact

The introduction of harvesting and threshing equipment can and does lead to displacement from paid employment of some of the poorest sectors of society unless used in circumstances where they permit higher cropping intensities or yields, thus creating alternative work opportunities in other farm activities.

In circumstances where the introduction of such equipment seems desirable from the point of view of the farmer, the employment and equity effects can be taken into consideration by enabling landless workers to purchase machinery through a credit scheme so as to run custom services. This type of scheme is being successfully implemented by various agencies in Bangladesh which have helped groups of landless men and women to benefit from the introduction of pedal threshers rather than be disadvantaged by them.

Ian Johnson
National Institute of Agricultural Engineering

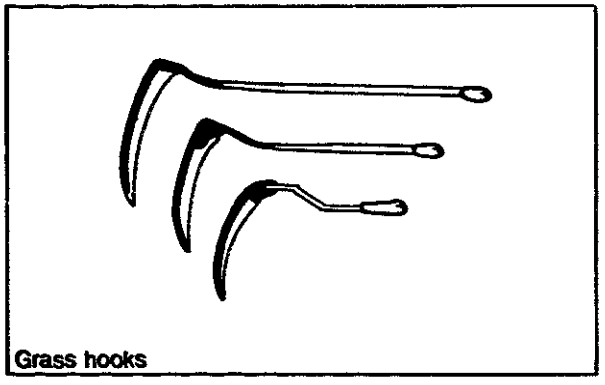
Reference:
RNAM (1983) *Testing, Evaluation and Modification of Cereal Harvesters. Technical Series No.14* Regional Network of Agricultural Machinery of the Economic and Social Commission for Asia and the Pacific. September 1983.

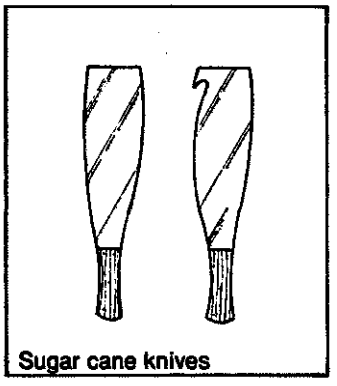
B. Operating cost per ha and per tonne of grain.

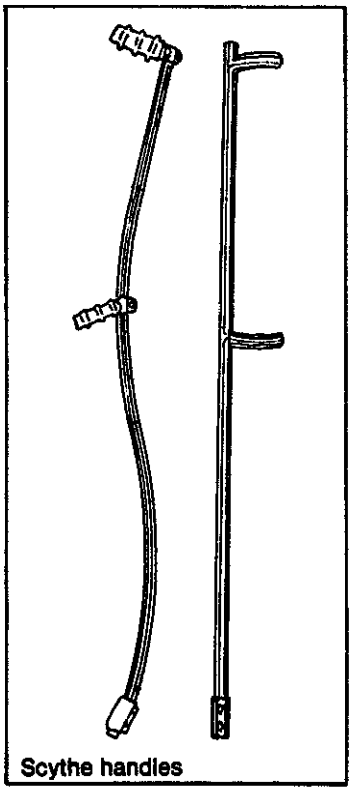
Prototype		*Mometora (Original)*					*Mometora (Modified)*
Country where tested		*India*	*Indonesia*	*Pakistan*	*Philippines*	*Thailand*	*Thailand*
Crop		Rice	Rice	Wheat	Rice	Rice	Rice
Capacity	hr/ha	15.9	15.6	13.2	12.5	10.5	10.0
Yield	t/ha	2.50	4.00	3.86	5.23	3.65	3.16
Grain loss	%	10.7	14.3	10.5	4.87	3.0	4.8
Labour requirement							
unskilled	man-ha/hr	39.9	162.9	57	64.9	33.5	33.5
skilled	man-hr/ha	16.0	27.8	13	12.5	19	19
Fuel consumption							
gasoline	l/ha	11.5	14.7	13	14.9	13.4	10.2
Price of grain	$/kg	0.15	0.15	0.10	0.15	0.15	0.15
Wage rate							
unskilled	$/day	0.76	0.8	1.01	2.27	2.00	2.00
skilled	$/day	1.9	2.0	2.53	5.68	5.00	5.00
Fuel price							
petrol	$/l	0.5	0.5	0.5	0.5	0.5	0.5
diesel	$/l						
Fixed cost	$/hr	1.07	1.07	1.07	1.07	1.07	1.07
Fixed cost	$/ha	17.00	16.69	14.12	13.38	11.23	10.70
Labour							
unskilled	$/ha	3.79	16.29	7.20	18.42	8.38	8.38
skilled	$/ha	3.80	6.95	4.11	8.88	11.88	11.88
Fuel cost	$/ha	5.75	7.35	6.5	7.45	6.70	5.10
Cost of grain loss	$/ha	40.15	85.80	40.53	38.21	16.43	22.75
Total cost per ha	$/ha	70.50 (30.35)	133.08 (47.28)	72.46 (31.93)	86.34 (48.13)	54.62 (38.19)	58.81 (36.06)
Cost per tonne	$/t	28.20	33.27	18.77	16.51	14.96	18.61

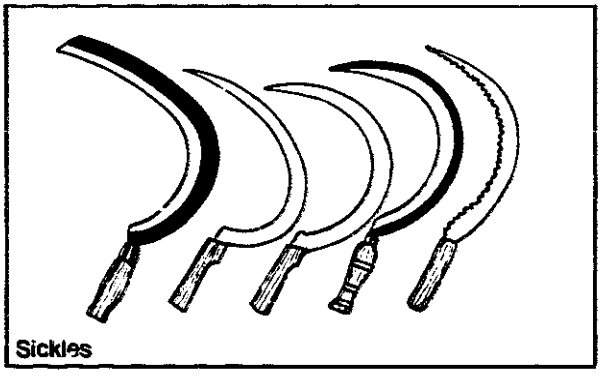
Note: Figures in parentheses are values excluding grain loss. Harvesting losses are extremely difficult to assess accurately. One approach is to estimate the yield by sampling, and then comparing this with the actual amount harvested, but sampling methods can seldom get closer than 2-3 per cent of the true yield, and this is the range of the expected harvesting loss.

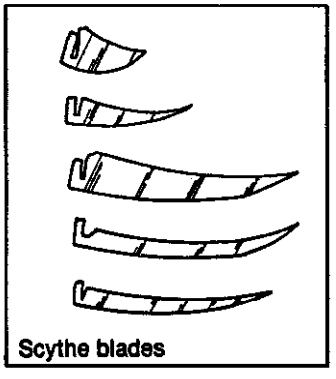
The alternative is to try and collect and count the grains on the ground before harvesting (pre-harvest loss) and after harvesting. The problem here is counting the pre-harvest loss without disturbing the crop and causing more loss. With this method of estimating, the result depends to a large extent on the investigator being able to find the lost grain. A good technician will usually record a much higher percentage loss than a lazy one. It is because most people estimate losses in this way in a very casual manner that in general harvesting losses are hopelessly underestimated.


Grass hooks


Sugar cane knives


Scythe handles

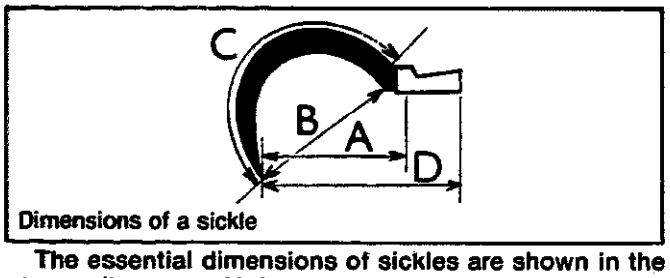

Sickles


Scythe blades

The use of a sharp blade to cut the plant stem is the simplest form of removing a crop. In each culture a different form of blade has been devised for each type of crop. The most renowned manufacturer of scythes and sickles, Falci from Italy, have dozens of designs specifically tailored to particular markets.

Sickles

The degree of curvature, length of blade, angle of attachment and the shape of handle, vary from area to area and for different crops. A small selection is shown above. Some sickles have serrated edges but there is little evidence to show this to be an improvement.



Dimensions of a sickle

The essential dimensions of sickles are shown in the above diagram. 'A' is the length of the implement, including the tang but excluding the handle. 'D' is the total length of the implement. The blade length is measured as the arc 'B' and the development of the blade 'C' is the length around the outer edge, up to but excluding the tang. The other measurement, not shown here, is blade thickness which is the longest width of the blade from outer edge to the sharp edge. Similar measurements are used to describe scythes. In both, the curvature and distance between the plane of the tang or the attachment to the snath (scythe handle) and the plane of the blade, is also noted sometimes by manufacturers: the 'tang height measurement' and (in scythes) the 'tang opening measurement'.

Scythes

These are long curved blades, usually 70 to 100cm long measured along the chord of the blade's arc (similar to dimension A in the drawing on the left), but shorter blades are available for difficult sites (e.g. steep banks). The shaft and handle (snath) designs vary in length and curvature to allow the operator to work with outstretched arms and both hands at approximately the same height from the ground. Scythes can be fitted with a cradle attachment which collects the cut crop and allows it to be deposited at the end of the stroke.

Grass or reaping hooks

These are a compromise between sickle and scythe.

Sugar cane knives

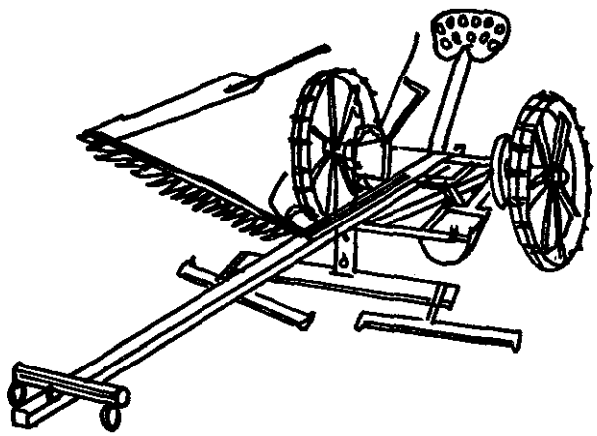
This form of implement has been designed to provide considerable momentum at the point of contact with the sugar cane stem. Often there is a hook on the back of the knife with which the cane is picked up for stacking or chopping into short lengths.

Explanation of table

The table overleaf lists the names of manufacturers of sickles, scythes and sugar cane knives, and the countries from which they come. The following columns give the number of different models of a specific type and their range of blade lengths, that is dimension in the drawing above left, the length of the back of the blade in cm. The number of sugar cane knives manufactured with hooks (h) or non-hooked (nh) is given. The length of handle of the long-handled grass hooks is given as well as their blade lengths. The following columns give the number of different types of scythe handles usually available, the number of different scythe blades manufactured, and their range of lengths.

Table of sickle, scythe and sugar cane knife manufacturers

Manufacturer	Country	Plain Sickle	Length cm	Serrated Sickle	Length cm	Sugar Cane Knife	Length cm	Short Grass Hook	Length cm	Long-Handled Grass Hook	Handle Length cm	Blade Length cm	Scythe Handles	Scythe Blade	Range of Blade Length cm
BULLDOG TOOLS	U.K.	4						1		2					
BURGON & BALL LTD.	U.K.	2	56 59					1		1			1	1	
CALDWELLS LTD.	U.K.	6	48- 58	3	48- 58	1h		1					1	1	
COLUMBIAN CUTLERY CO.	U.S.A.	4	35 c					2		2	90 130	45			
EICHER GOODEARTH LTD.	INDIA	1		1											
FALCI	ITALY	90	24- 44	38				6		2				84	40- 80
FERFOR	PORTUGAL	2													
HERRAGUA	GUATEMALA					1h 1nh	35								
HERRAMIENTAS AGRICOLAS NACIONALES	ECUADOR					1h	37								
T. & J. HUTTON CO. LTD.	U.K.			3	52										
IMACASA	EL SALVADOR					1h									
JENKS & CATTELL LTD.	U.K.							1		1					
KENYA ENGINEERING INDUSTRIES	KENYA					1h	52								
KUMAON NURSERY	INDIA	2	40 45	2	40 45	1nh	30								
KUMAR INDUSTRIES	INDIA					1nh	35								
LYSBRO FABRIKER A-S	DENMARK												1	3	65- 95
MAHARASHTRA AGRO-IND. DEVELOPMENT CORP.	INDIA					1h									
MODERN ENGINEERING COMPANY	INDIA			1											
AB NORBERGS SPAD & REDSKAPSFABRIKER	SWEDEN											3	6	9	51- 74
RALPH MARTINDALE & CO.	U.K.					3h 3nh	28- 37								
SANDVIK AB	SWEDEN			2	45- 50			1	30				1	2	55 65
SEYMOUR MANUFACTURING COMPANY	U.S.A.	2		2				2	30	2	110 120	30 40	2	5	40- 85
S.I.C.F.O.	FRANCE			1	45								1	2	50 65
A. SPALDING & SON LTD.	U.K.									1			1	3	
SPEAR & JACKSON LTD.	U.K.	7	33- 39					1	30	1	89	30	1	5	60- 91
SYNDICAT DE L'OUTILLAGE AGRICOLE ET HORTICOLE	FRANCE	1		1											
TRAMONTINA SA	BRAZIL	4	25- 27							1		22			
TROPIC	CAMEROON					1nh									
W. TYZACK SONS & TURNER PLC.	U.K.							1		2	91 107	32 40	3	13	60- 100
WOLF & BANGERT	W. GERMANY					5nh 12h	27- 37								
ZANA ZA KILIMO LTD.	TANZANIA	1													



ANIMAL-POWERED GRASS CUTTER

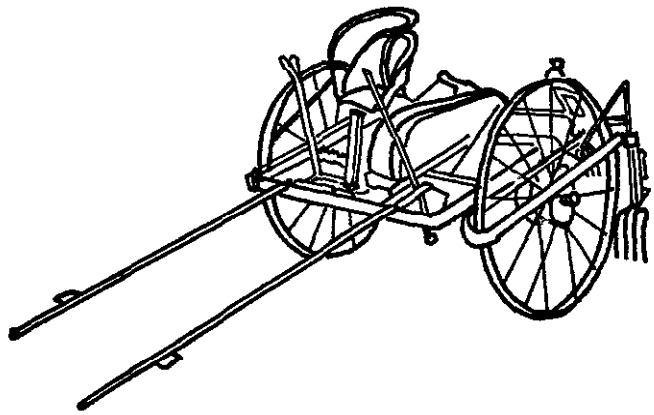
The model 9G-1.4 grass cutter is drawn by two horses and used mainly for mowing grass, other forages, reeds and similar crops. It is suitable for small areas.

Technical specifications:

length	5.03m
width	2.87m
cutting width	1.37m
height of cut	53mm
capacity	3.3 ha/h
weight	328kg.

Manufactured by the Stock Raising Machinery Factory, Hailar City and available through:

CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing
CHINA



Z-208 HORSE-DRAWN HAY TEDDER

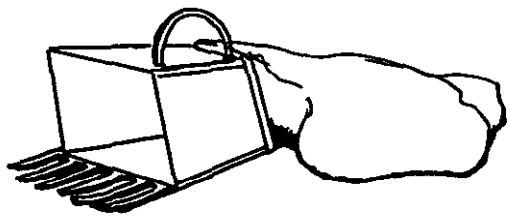
The Z-208 is a hay conditioner designed for tedding grass being dried for hay. The two wheels are equipped with latch clutches by means of which the drive is transmitted to the tedding forks. Only one horse is required to drive the implement even under very hard field conditions.

Technical specifications:

no. of tedding forks	6
working width	2.1m
capacity	0.6-0.8ha/h
wheel diameter	1m
weight	270kg

Manufactured by Powogaz, Pita and available through:

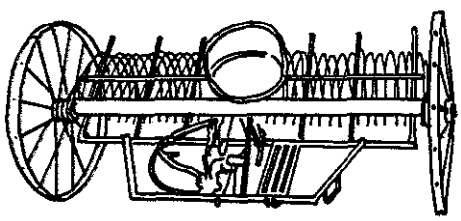
AGROMET MOTOIMPORT
Foreign Trade Enterprise
P.O. Box 990, Warsaw
POLAND



BUFFEL GRASS SEED HARVESTER

A simple tool for harvesting matured buffel grass seed in the standing crop. It is available in two models. Model 1 is smaller and consists of a box with 6 prongs, a handle and collecting bag. It has a capacity of 20-30kg/day and is used by one person. Model 2 is for use by two people and has a capacity of 60kg/day. The tool requires $^{1}/_{10}$ of the time for harvesting grass seeds compared to the hand picking techniques commonly used in many countries.

OFICINA VENCEDORA
Av. sete de Setembro 599
56.300 Petrolina, PE
BRAZIL



Z-204 HORSE-DRAWN RAKE

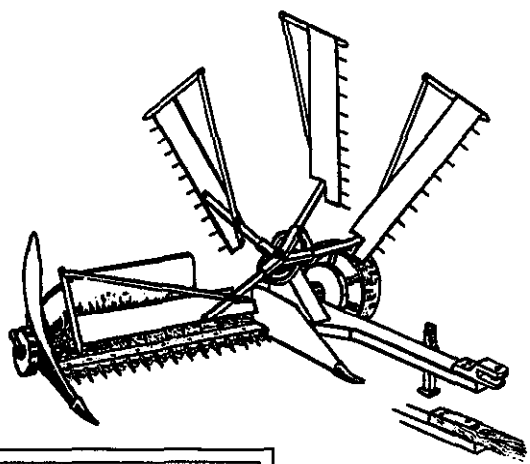
The versatile Z-204 horse-drawn rake is designed for raking hay into rows for drying, and raking all crop remnants left on the field after harvest. It can be used for raking potato leaves and branches. The rake consists of the front frame, rake tine assembly and ground wheels. All assemblies are mounted on the carrying beam. It is equipped with a driver's seat and 30 main tines and 2 side tines of adjustable height.

Technical specifications:

traction force	1 horse
capacity	1ha/h
working width	2m
length	4m
width	2.6m
weight	205kg

Manufactured by Agromet-Famarol, Stupsk and available through:

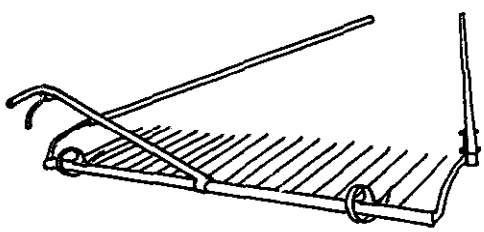
AGROMET MOTOIMPORT
Foreign Trade Enterprise
P.O. Box 990, Warsaw
POLAND



SAIL REAPER

The sail reaper is ideal for rice and other cereals. It has a 1.67m wide cutter bar with reciprocating knife. This cuts the crop which falls on the collecting tray and is swept off sideways by the rotating sails clear of the standing crop for tying up by hand. Alternatively it may be followed by a mobile thresher. The machine is available with other cutting widths and as a tractor or animal-drawn implement with optional diesel engine drive. The reaper has a robust construction of good quality steel.

ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.

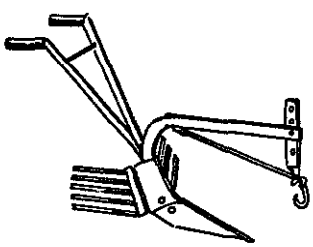


DRAG RAKE

This rake is built for horse-drawn operation and is used for raking grass and hay. It is easy to work with, and has a single handle. For emptying, the lever on the handle is pressed so that the handle drops and grasps the next notch on the pivot at the base of the handle shaft. When the horse pulls, the rake rotates and the teeth rest backwards. When the handle is lifted again the rake rotates to its original position. The teeth are of tempered spring steel, the main frame and handles are made of tubular steel, and the side bars are wooden.

There are six models with working widths ranging from 1.8m to 2.7m, weights from 54 to 59kg, and from 12 to 20 tines.

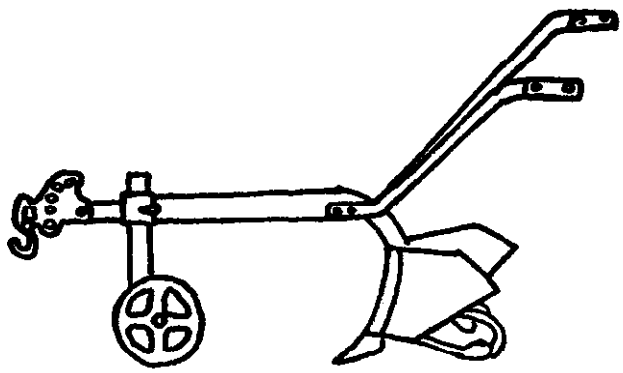
K.K. LIEN FABRIKK A/S
Trompy, Arendal
4812 Kongshamn
NORWAY



POTATO LISTER

This is an animal-drawn lister with a bent beam, handle and lifting blade with finger mouldboard. It is designed for lifting root crops grown in ridges.

AGRICOLA
34 rue Beni Amar, Casablanca
MOROCCO



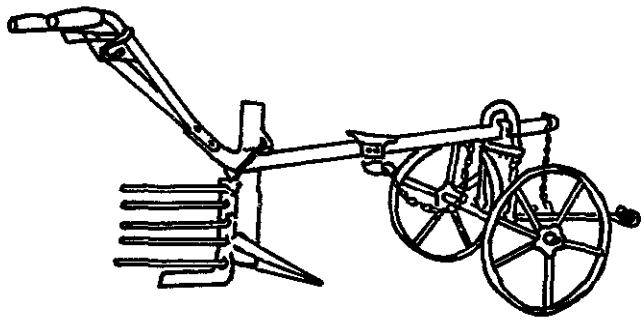
POTATO LISTERS

Agromet Motoimport of Poland export a number of potato harvesting implements. These are known as potato listers, or spinners.

P-418/0 HORSE-DRAWN POTATO LISTER This model (illustrated) is designed generally for earthing up crops planted in ridges, but is also usable for potato harvesting. The lister consists of the central curved body beam to which are attached the handles, digging body and adjustable towing hitch. The latter ensures a correct working depth. The 2 mouldboards of the digging body are mounted on hinges and may be set according to required working width. The lister weighs 20kg.

Manufactured by Wytwórnia Urz. Komunalnych, Kalisz and available through:

AGROMET MOTOIMPORT
Foreign Trade Enterprise
P.O. Box 990, Warsaw
POLAND

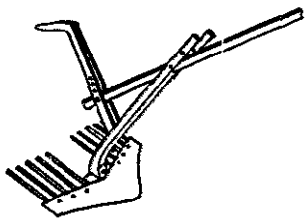


The Z-402 BEET DIGGER

The Z-402 Beet Digger is designed for earthing up topped and untopped beetroots. Mounted on a 2-wheeled carriage plough frame, it consists of two principal components: 2 digging stumpers and bushes which are welded to the plough frog, and the rear shoe. The rear shoe itself is made up of a 5-rod grid for turning the earthed-up beetroots aside, and is attached to a support bolted to the plough frog. The entire digger is mounted on the central beam of the plough frame by a solid-state yoke and 2 holding bolts. The digger is a single-row implement and requires the equivalent draught of 2 horses and the attendance of 2 workers. It has an average daily field output of 1ha and weighs 20kg (without 2-wheeled carriage plough frame).

Manufactured by Wytwórnia Urz. Komunalnych, Kalisz and available through:

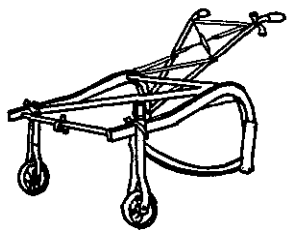
AGROMET MOTOIMPORT
Foreign Trade Enterprise
P.O. Box 630, Warsaw
POLAND



POTATO DIGGER

A simple potato lifting implement designed to be drawn by a single bullock. It has a mean capacity of 0.25ha/day and is able to earth up 98 per cent of the crop, damaging as little as 1 per cent.

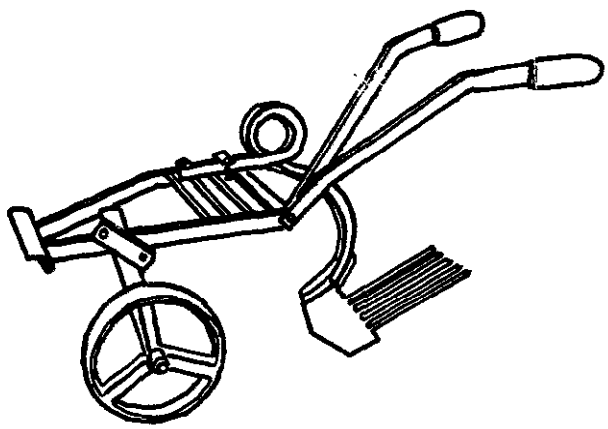
GOV. IMPLEMENT FACTORY, M/S
Satya Nagar
Bhubaneswar 75100, Orissa
INDIA



ANIMAL-DRAWN GROUNDNUT LIFTER

Weighing 55kg, this implement is fabricated from easily available forged and cast iron components which may be assembled with the use of a single spanner.

AGRIMAL (MALAWI) LTD.
P.O. Box 143, Blantyre
MALAWI

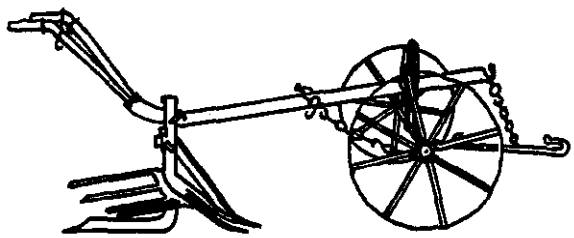


PEANUT DIGGER

Alvan Blanch manufacture the peanut digger illustrated above. It is based on a similar principle to the potato lifters or listers described on this page. It consists of a simple frame to which a ground wheel, handles and digging body are attached.

The digging body comprises a blade which lifts the peanut plants from a depth of about 10-12cm. A finger mouldboard separates the plants from the soil and leaves them upturned on the surface where they are left to dry. This means that the mud on them can easily be removed. The Alvan Blanch peanut digger is designed for animal draught.

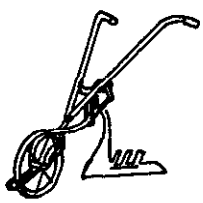
ALVAN BLANCH DEV. CO. LTD.
Chalmorth
Malmesbury, Wilts. SN16 9SG
U.K.



BEET PLOUGH

This beet plough is essentially similar to that produced in Poland (see above). It is mounted on a 2-wheeled carriage plough frame and requires the draught of 2 horses or bullocks. The digger consists of a curved plough bar or frog to which is attached a 2-finger ridging body. It is also equipped with a coulter and 4 mouldboard fingers which direct the earthed-up beetroots away to the right side of the digger. This is manufactured by Super Talu S.A. of Brazil and is available through:

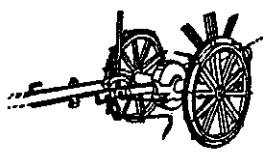
TECHNICAL ASSISTANCE (INTERNATIONAL)
P.O. Box 1224
Vossiuhlenweg 2
2072 Bargteheide
W. GERMANY



CECOCO PEANUT DIGGER

The Cecoco peanut digger lifts peanut plants from a depth of 10-12cm. Two models are available, one for animal draught and the other for power tiller drive (3-6hp). Capacity ranges from 1.2ha/h (animal draught) to 1.5ha/h (power tiller).

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

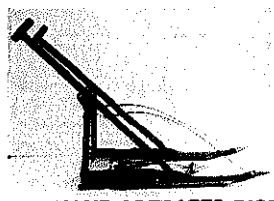


THE X-602/0 POTATO SPINNER

The spinner is used to dig out potatoes and to separate them from stalks and soil clods by means of a rotating digging reel. The reel is driven by a gear transmission from the ground wheels.

Manufactured by FMR, Strzelce Opolskie and available through:

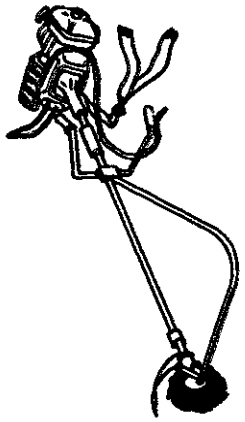
AGROMET MOTOIMPORT
Foreign Trade Enterprise
P.O. Box 990, Warsaw
POLAND



SM2 HAND-OPERATED RICE PLANT CUTTER

Used in the same manner as a scythe, this cutter is equipped with scissor blades which are moved by a cable attachment. The cutter handle is steel pipe and the blades are removable for sharpening.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN



'MOTORSCYTHE' SWATHER

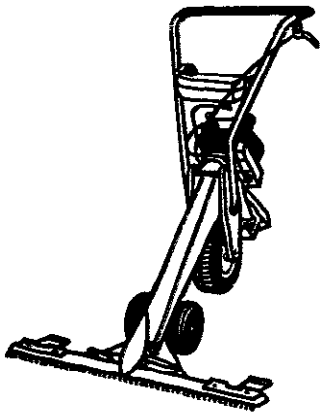
The Motorscythe Swather is a lightweight, heavy-duty rotary cutter suitable for tasks ranging from land clearance to harvesting small cereal plots.

The swather weighs 10kg and is equipped with the following:

- 35cc petrol engine
- shoulder harness
- double-handed control bar
- swathing bat for clearance of standing crops into rows
- tooth whirl blade with guard.

The interested reader is referred to the description of land clearance equipment in Section 13 (Miscellaneous) where a range of brush cutters similar to the 'Motorscythe' is listed.

ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.



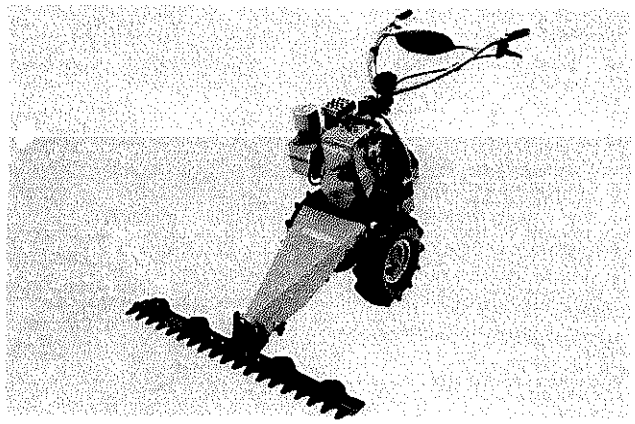
SMALL MOTORIZED GRASS CUTTERS

Alpina manufacture 2 small motorized grass cutters.

THE MODEL HOBBY 202 This consists of a tubular transmission shaft to which is attached the engine, handle-bars, ground wheels and cutter bar mower. It is a lightweight implement (18kg) suited to steep and inaccessible areas of up to 0.2ha. The engine is 2-stroke with an 85cc displacement. This motivates the cutter bar which has an adjustable working height and width of 80cm.

THE MODEL ELITE 402 Although this model (illustrated) is equipped with a similar 85cc, 2-stroke engine and 80cm cutter bar, its heavier construction (25kg) and additional land wheel allow it to be used on large areas. An output of up to 0.1ha/h may be achieved.

ALPINA
31015 Conegliano, Treviso
ITALY



5HP GRASS CUTTERS

Motorized grass cutters in the 5hp range have the advantage of being versatile enough for use in quite difficult terrain, while having sufficient power and capacity for working in quite large areas. The 3 models described here are manufactured in West Germany and Austria and are available for export.

THE AGRIA 5300 This model (illustrated) is able to harvest grass at a rate of up to 0.3ha/h, the Agria 5300 has the following characteristics: combined speed control and engine cut-out mechanism; forward, reverse and idling gears controlled by a single coupling lever; 4-stroke, 5hp petrol engine with recoil starter; pneumatic tyres or cage wheels; independent traction and mowing mechanisms; fingerless 100cm wide cutter bar; total weight 75kg.

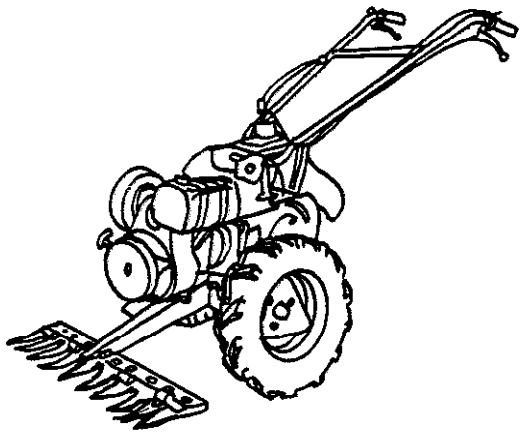
AGRIA-WERKE GmbH
Postfach 1147
7108 Möckmühl
W. GERMANY

THE REFORM 115 DIESEL MOTOR MOWER A very sophisticated machine able to carry out a range of tasks in addition to grass cutting. The mower is driven by a Lombardini diesel LDA 520, 4-stroke, 325cc, air-cooled engine which develops 5DIN HP at 3000rpm. It has a fuel consumption of less than 1 litre/h and is equipped with 2 forward and 2 reverse gears. The grass cutting capacity of the 115 motor mower is enhanced by a range of 3 different cutter bars, each suited to certain conditions and grass types. These give cutting widths of 1.4-1.7m. Also available are additional wheel attachments for extra stability (e.g. cage wheels).

REFORM-WERKE BAUER & CO. GmbH
Postfach 192
Haidestraße 40
A-4600 Wels
AUSTRIA

BM 100/2G This mower is the largest of a range of three produced by Gutbrod. It has a cutting width of 100cm and a Gutbrod 2-stroke motor with an output of about 3.7kW.

GUTBROD-WERKE GmbH
Postfach Box 60
6601 Saarbrücken-Bübingen
W. GERMANY



GRASS CUTTERS

The grass cutters described here are similar in form to those of 5HP listed on this page. Their primary function is grass harvesting although they may also be adapted for other mechanized functions. Here, the interested reader requiring information on multi-purpose power tillers, many of which include grass cutter bar attachments, is referred to the relevant pages on motorized tillage in Section 1 of this Guide.

THE MONROTILLER MOTOR SCYTHE This model (illustrated), although designed principally for grass cutting work, may be adapted to perform a range of functions in soil tillage and traction. Accessories include:

- extra diameter pneumatic wheels
- primary tillage equipment
- tool frame attachment
- trailer hitch (sprung or heavy-duty)
- blanking plate for side PTO

MECHGARD LTD.
Great Gransden, Sandy
Bedfordshire SG19 3AY, U.K.

THE BEBY MOTOR SCYTHE An implement with the following technical characteristics:

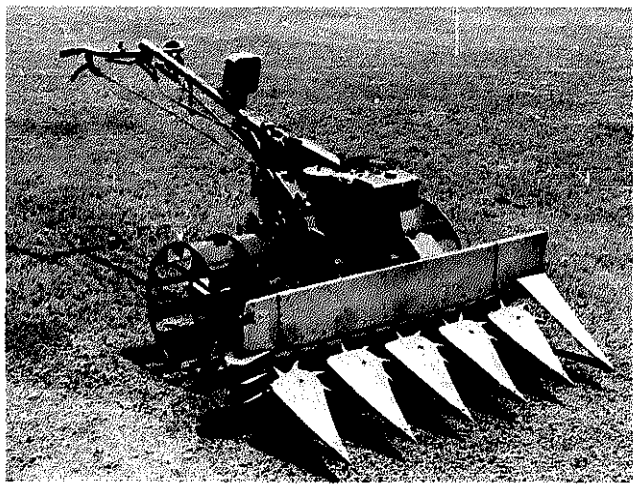
- 5HP (DIN), 4-stroke petrol engine
- PTO (frontal)
- mowing bar adjustable up to 70cm
- weight 78kg
- spraying pump attachment.

BARBIERI, SpA
Via Circonvallazione, 19
36040 Sossano, Vicenza
ITALY

THE FORMICA 2 M This is similar to the Beby motor scythe, this model has technical specifications which include:

- 5hp, 2-stroke engine
- 2 forward speeds
- adjustable handlebars
- weight 55kg
- lister, trailer and cultivator.

M.A.B. DI GUIDO BOCCHINI
Via Erbosa, 47030 Gatteo (F.O.), ITALY



CAAMS-IRRI 1.6m REAPER

Designed by the International Rice Research Institute (IRRI) in collaboration with the Chinese Academy of Agricultural Mechanisation Sciences (CAAMS), this large reaper is particularly suited to the harvesting of rice.

It has a 6-8hp power requirement and a daily output of approximately 3.8ha. The following gives the reaper's technical specifications: power; 6-8hp petrol engine; gross weight; 255kg; weight of reaper; 77kg; field capacity; 0.38ha/h; field losses; less than 1%; forward speed; 3-5.5kph; fuel consumption; 1.6 litres/h.

F. BUENACOSA REPAIR SHOP
Tecurong, Sultan Kudarat
PHILIPPINES

POYING'S WELDING SHOP
262 National Hi-Way
Bayy, Anos, Los Banos, Laguna
PHILIPPINES

JCCE INDUSTRIES
242 Mayondon
Los Banos, Laguna
PHILIPPINES

CAAMS — IRRI 1.0m REAPER

This motorized reaper has been developed by the International Rice Research Institute in collaboration with the Chinese Academy of Agricultural Mechanization and Sciences.
Technical specifications:

- engine type; petrol
- power output; 3hp
- labour requirement; 1-3 men
- capacity; 2.4ha/day
- cutting height; 70mm
- speed; 2.5 to 4.5kph
- length of reaper-tiller unit; 2.18m
- weight; 135kg
- fuel consumption; 1 litre/h.

The reaper is produced by the following manufacturers:

ALPHA MACHINERY & ENGINEERING CORP.
P.O. Box 579 MCC
Makati, Metro Manila, D708
PHILIPPINES

B-J ENGINEERING & MACHINE WORKS
1238 Rizal St., San Jose
Baliwag, Bulacan
PHILIPPINES

BORJA MACHINE SHOP
Sgt. de Roma St.
San Pablo City, Laguna
PHILIPPINES

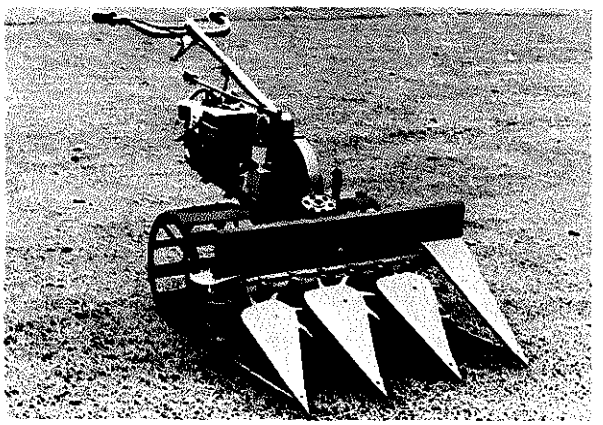
GINTONG ANI METALWORKS
Cainta, Metro Manila
PHILIPPINES

M&P ENGINEERING
KM 16 MacArthur Highway
Malanday, Valenzuela
Metro Manila
PHILIPPINES

POYING'S WELDING SHOP
262 National Hi-Way
Bagy, Anos, Los Banos, Laguna
PHILIPPINES

2M INDUSTRIAL COMPANY
San Mateo, Isabela
PHILIPPINES

F. BUENACOSA REPAIR SHOP
Tacurong, Sultan Kudarat
PHILIPPINES



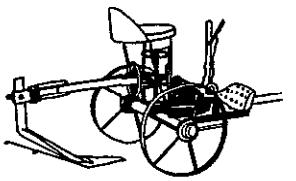
FELICIANO AGRICULTURAL MACHINERY & WELDING SHOP
Midsayap, North Cotabato
PHILIPPINES

KABACAN ENGINEERING WORKS & SERVICES
Rizal Ave., Kabacan
N. Cotabato
PHILIPPINES

PETER LIMS ENTERPRISES
San Francisco, Agusan del Sur
PHILIPPINES

ROSMAN MACHINE SHOP
Valencia, Bukidnon
PHILIPPINES

MARINAS MACHINERY MAN. CO. INC.
Rizal Street, Pila, Laguna
PHILIPPINES

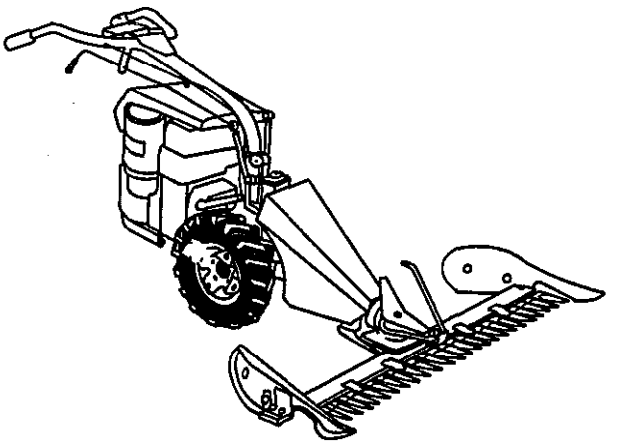


SWEET POTATO LIFTER

It lifts potatoes grown in ridges and leaves them on the surface of the ground *to be picked by hand. It has a lifting* depth of 19cm.

Manufactured by the Municipal Institute of Agricultural Machinery, Beijing and available through:

CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing
CHINA



GRASS CUTTERS

These motorized grass cutters have a power output greater than 5hp. They are equipped with a front cutter bar.

CORTINA/C GRASS CUTTER This model is shown in the illustration with a symetrically attached cutter bar. A lateral version is also available. It has a 10hp petrol or diesel engine with power take-off and 3 speeds, including reverse. Other attachments include a ridger, spray and irrigation pump, plough, trailer *and circular saw.*

BARBIERI, SpA
Via Circonvallazione, 19
36040 Soessano, Vicenza
ITALY

GRASS CUTTER MODEL 131 Available with either central or lateral cutter bars. The power output is 5, 7, or 9hp, and the gear box provides 3 speeds, 2 forward and 1 reverse. The cutting width is from *650 to 1270mm.*

BERTOLINI MACCHINE AGRICOLE, SpA
42100 Reggio Emilia
Via Guicciardi 7
ITALY

790 MOTOR SCYTHE Available with either central or lateral cutter bars. The petrol engine has displacement from 300 to 350cc. At 3600rpm there are 3 forward speeds from 2.3 to 10.2kph and one reverse. Other attachments include: circular saw, compressor, various mowing bars, harvesting attachment, grinder.

O.M. FERRARI, SpA
Via Valbrina 19
42045 Luzzara (R.E.)
ITALY

GRASS CUTTERS MODELS GB 444 and GB 495 The GB 444 has a 4-stroke, 127cc petrol engine. It has a central cutter bar and cutting width of 70cm. The GB 495 is a larger model with a 4-stroke, 161cc engine and cutting width of 110m.

GRANJA, S.A.
109 route de Toulouse
31270 Cugnaux
FRANCE

REFORM 715 MOTOR MOWER Powered by a 4-stroke petrol engine with a power output of 8hp. It has 3 forward speeds from 2.4 to 15km/h and 1 reverse.

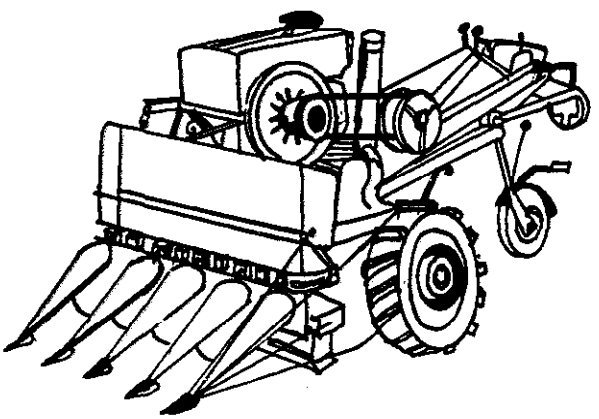
REFORM-WERKE BAUER & CO. GmbH
Postfach 192
Haidestraße 40
A-4600 Wels
AUSTRIA

GRASS MOWERS S.E.P. produce a number of machines with either central or lateral cutter bars. Their widths range from 95 to 144cm.

S.E.P.
Fabbrica Macchine Agricole s.r.l.
42018 S. Martino in Rio (RE)
ITALY

A similar 10hp mower with central cutter bar is produced by Pasquali.

PASQUALI SpA
50041 Calenzano (Firenze)
via Nuova, 30
ITALY



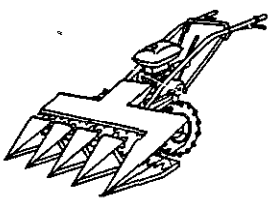
CHINESE HARVESTERS

BEIJING NO. 2 WHEAT AND RICE HARVESTER Designed to be mounted on the front of the Gong Nong 12 walking tractor, this harvester (illustrated) features a vertical table, and a specially designed star wheel lifter instead of a reel. The cut grain is delivered by the conveyor to the right side of the machine *to be swathed. Maximum lifting height is* 250mm, and mininmum cutting height is 60mm.

GANSU 160 WHEAT WINDROWER This machine can be mounted on a 12hp walking tractor and is designed for harvesting wheat crops from 50-120cm high. It has a vertical cutting platform, a reel unit for lifting and a reciprocating cutting bar.

Manufactured by the Tong Xian *Harvester Plant, Beijing and available* through:

CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing
CHINA



HARVESTER TILLERS

KULIGLIG PALAY HARVESTER Powered *by a 3 or 5hp petrol engine, this harvester* has a capacity of up to 2.5ha/day. Two people are required to operate it. Overall weight is 150kg, length 250cm, width 118cm

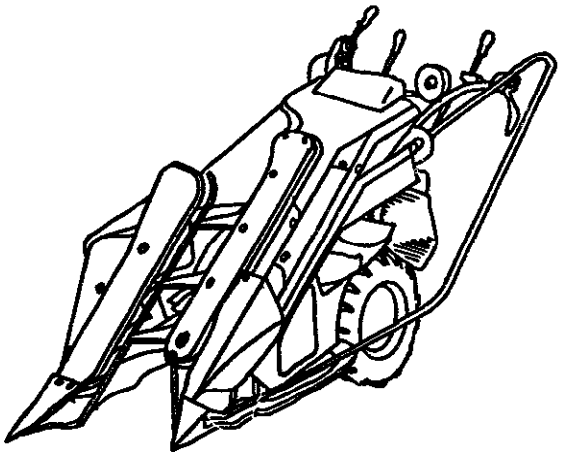
P.I. FARM PRODUCTS
KM 16, Malanday,
Valenzuela, Metro Manila
PHILIPPINES

AGAD REAPER Designed for harvesting paddy, the Agad reaper can be used on wet or dry fields. It requires a 5hp engine and has a capacity of up to 2.4ha/day.

C & B CRAFTS
Maginao, San Rafael, Bulacan
PHILIPPINES

KUBOTA REAPER AR120 This model (illustrated left) has a reciprocating knife bar cutting device, with a cutting height of 10-30cm and a cutting width of 120cm. There is one forward and one reverse gear, with respective speeds of 3.5kph and 3.03kph. The overall weight is 116kg, *and power output is 3.4PS (petrol* engine). Optional cage wheels are available.

KUBOTA LTD.
2-47 Shikitsuhigashi 1 — Chome
Naniwa-Ku, Osaka 556-91
JAPAN



REAPER-BINDERS

Motorized reaper-binders are a development of the more usual power tiller with cutter bar. Although the reaper-binder's cutting width is smaller than that of a cutter bar mower, this is compensated for by the binding mechanism which gathers up the cut grass or cereal, and ties it into sheaves. The latter is a very time-consuming and labour-intensive operation if done by hand alone.

SUZUE BINDERS There are 2 models in this range, the 1-row, 2-wheel Bx300S, and the 2-row, 2-wheel B600DB. The binding is of the knotter and bill type and is carried out with twine.

SUZUE AGRICULTURAL MACHINERY CO. LTD.
144-2 Gomen-cho
Nankoku-shi, Kochi-ken 783
JAPAN

KOREAN BINDERS Listed here are 3 models of binder available for export from Korea. They are the RX-550, KB-602 and HE-50A.

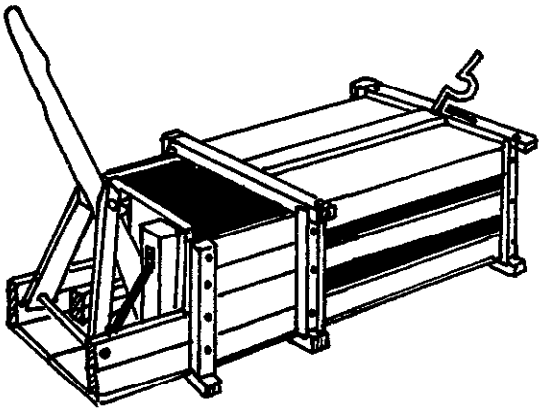
MODEL RX-550: air-cooled petrol engine developing 4.0hp at 4000rpm. It has a weight of 161kg, an average speed of 0.86m/sec, and a cutting width of 50cm. Manufactured by Tong Yang Moolsan Co. Ltd.

MODEL KB-602: air-cooled, 4-stroke petrol engine developing 4.5hp. It has a cutting width of 55cm and a capacity of 4ha/h. Manufactured by Kukje Machinery Co. Ltd.

MODEL HE-50A: a 168kg implement driven by a 4-stroke petrol engine which develops 4.2hp at 3400rpm. An average working speed of 0.85m/sec and working width of 45cm may be expected. Manufactured by Dae Dong Ind. Co. Ltd.

These three binders are all available through:

KOREA TRADE PROMOTION CORPORATION
C.P.O. Box 1621, Seoul
KOREA

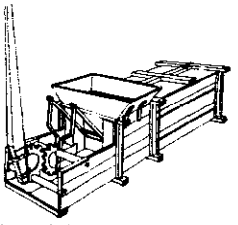


HAY BALERS

Equipment for the baling of hay has been devised in most livestock-raising areas where there is concern to maintain production levels during periods of poor pasture production and where there is an excess of forage produced during the growing season. Hay bales are more easily transported than loosely stacked material and, so long as they are tied with resilient twine or with wire, will remain in solid form for a considerable length of time. Much of the hand-operated equipment is locally made, and consists of a chamber with one or more sides which compress the hay ready for tying.

ENFARDADORA TIPO 1 This simple device (illustrated above) compresses the hay in a small reinforced box of dimensions 72 by 58cm. The length of the compression box is 110cm. By repeated additions of hay to the box a complete bale can be formed.

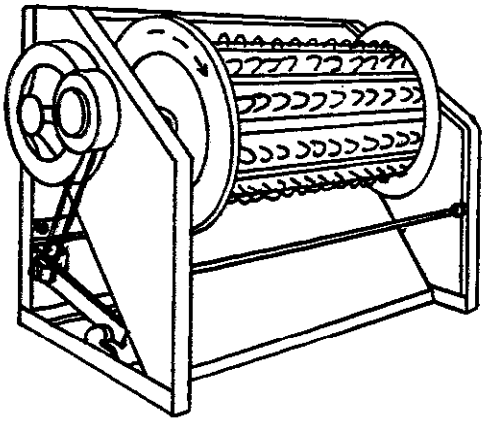
ENFARDADORA TIPO 2 This more sophisticated baler (illustrated right)



produces bales of approximately the same size but, as can be seen, the feed arrangement and the compression mechanism are different allowing for a more rapid formation of denser bales. There are similar slits in the sides through which the bale twine can be placed.

Construction details for both models available from:

G.I.A.
Ricardo Matte Pérez 0324
Casilla 6122, Correo 22
Santiago
CHILE



TREADLE THRESHERS

Suitable for most types of grain, treadle (often called 'pedal') threshers consist of a frame supporting a peg drum which is rotated on a horizontal axis by a foot-operated treadle board. The sheaves are held close to the pegs on the rotating drum, and the grain is thus separated from the straw. Average outputs from this type of thresher would be in the range of 25-30 kg/h. Treadle threshers are available from the following manufacturers:

WEST BENGAL AGRO-INDUSTRIES CORPORATION LTD.
238 Netaji Subhas Road
3rd Floor, Calcutta 700 001
INDIA

LIGHT ENGINEERING INDUSTRIES (PTE) LTD.
127 Kottawa Road, Nugegoda
SRI LANKA

RAJAN UNIVERSAL EXPORTS (MFRS) PVT. LTD.
'Raj Buildings'
162 Linghi Chetty Street
Post Bag 250, Madras 600 001
INDIA

KOREA TRADE PROMOTION CORPORATION
C.P.O. Box 1621, Seoul
KOREA

UNION FORGINGS
Focal Point
Sherpur, Ludhiana, Punjab
INDIA

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

AMERICAN SPRING & PRESSING WORKS PVT. LTD.
P.O. Box 7602
Adarsh Housing Society Road
Malad, Bombay 400 064
INDIA

AGRITOM
6 rue de Strasbourg
92600 Asnières
FRANCE

TREADLE THRESHERS

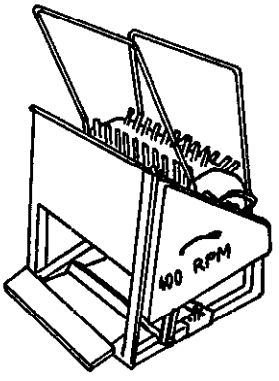
1A RICE THRESHER Equipped with a toothed drum and steel frame, this foot thresher (illustrated) can also be adapted for motor drive. The thresher weighs 100kg, and the drum has a diameter of 420mm and a width of 490mm. A similar heavier (160kg) model is also available from Musuhama.

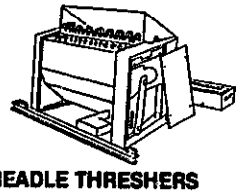
STANDARD LANDMASCHINEN GmbH
Postfach 1160
3118 Bad Bevensen
W. GERMANY

C.V. MUSUHAMA
Jl. Raya Kajen 248
Tegal, Jawa
INDONESIA

FOOT THRESHER The drum is fitted with steel wire teeth and capacity ranges from 90-130kg/h. Overall weight is 40kg.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN



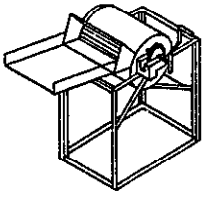


TREADLE THRESHERS

PADDY THRESHER Sismar produce this treadle thresher (illustrated) which can be adapted for motor drive. It has a capacity of 150-250kg/h, and an optional recuperation hood and tub. A similar model is manufactured by Tropic:

SISMAR
B.P. 3214
20 rue Dr. Theze, Dakar
SENEGAL

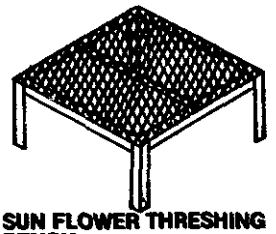
TROPIC
B.P. 706, Douala
CAMEROON



MANUALLY-OPERATED CASTOR THRESHER

This thresher consists of a teak wood cylinder and concave, a feed hopper and an outlet chute, all mounted on an angle-iron frame. The cylinder is rotated by a hand crank.

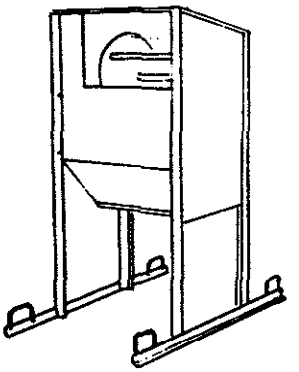
ANDHRA PRADESH AGRICULTURAL UNIVERSITY
Rajendranagar
Hyderabad 500 030
INDIA



SUN FLOWER THRESHING BENCH

Designed to reduce the time and labour requirements involved in conventional threshing methods. The bench is fabricated from M.S. angle pieces and wire mesh.

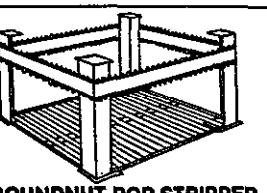
ANDHRA PRADESH AGRICULTURAL UNIVERSITY
Rajendranagar
Hyderabad 500 030
INDIA



N'DOFFANE GROUNDNUT POD-STRIPPER

This hand-operated groundnut thresher consists of a system of wooden beater bars rotating in a body constructed from angle iron and steel sheet. A table is normally supplied for feeding in the plants. The deflecting sheet is fitted around the beater to allow the nuts to be collected under the machine. The capacity is approximately 200kg/h. The N'Doffane is particularly suitable for stripping undried confectionery groundnuts.

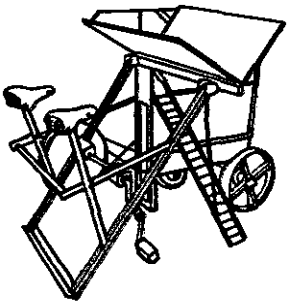
SISMAR
B.P. 3214
20 rue Dr. Theze, Dakar
SENEGAL



GROUNDNUT POD-STRIPPER CUM PADDY THRESHING BENCH

The goundnuts are drawn against the comb, stripping the pods from the plant and leaving the nuts in the hands of the operators. The device can be inverted so that the grill is uppermost, and used as a paddy thresher.

ANDHRA PRADESH AGRICULTURAL UNIVERSITY
Rajendranagar
Hyderabad 500 030
INDIA



BICYCLE-TYPE THRESHERS

A quite efficient manual threshing method is employed by machines based on the bicycle. One or two operators are required to feed the hopper while providing the power, via a V-pulley, to the threshing mechanism.

THE MINI 'R' PEDAL THRESHER This is suitable for rice and most other cereals (optional accessories available for sorghum). The unit is operated by 2 men. A sloping sieve at the discharge point helps separate the straw from the grain which can be collected in a shallow skip or sheet. The thresher is equipped with twin wheels and has an output of up to 200kg/h.

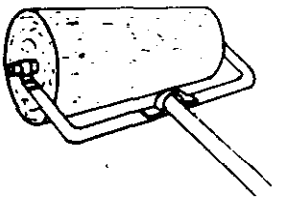
THE MINI 'M' PEDAL THRESHER This model (illustrated) is similar to the Mini 'R' but designed specifically for threshing millet. This is achieved through rubber beaters operating against steel concave bars over heavy gauge perforations. Output is up to 100kg/h.

Both the Mini 'R' and Mini 'M' threshers may be equipped with a motor, and are available from:

ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.

THE MIDC PEDAL THRESHER Powered by one person, this implement was developed by the Metal Industries Development Center (MIDC) using locally available materials. It has a total weight of 38kg and an optimum pedal speed of 65rpm.

METAL INDUSTRIES DEV. CENTER
Jalan Sangkuriang 12
P.O. Box 113, Bandung
INDONESIA



STONE THRESHING ROLLER

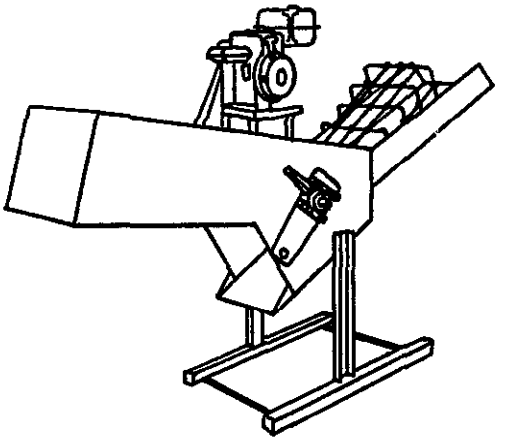
This threshing roller is tapered so that it can easily be pulled round in circles over the crop by animals.

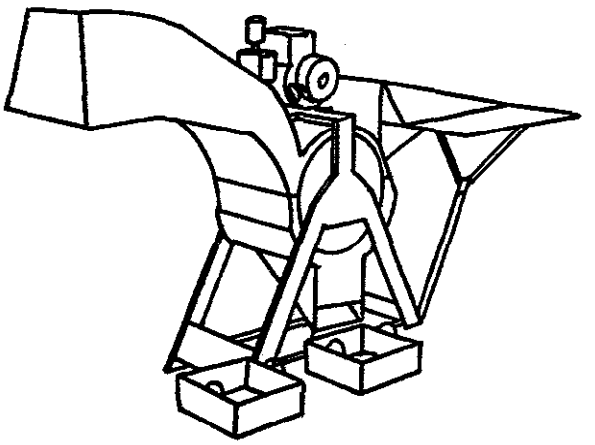
DANDEKAR BROTHERS
Sangli-Shivaji Nagar, 416 416
Maharashtra
INDIA

ANIMAL-DRAWN OLPAD THRESHER

This machine comprises serrated discs of 450mm diameter mounted on a steel shaft, and held in position by cast iron spools. The frame is of angle iron and includes a seat with foot and back rest for the operator. Back and front safety guards eliminate the risk of injury to the operator. The harvest is spread on the threshing floor and the machine is drawn round and round, thus separating the grain. An extra raking attachment can be fitted for stirring the straw during the threshing operation. The thresher is available in 20, 14, 11, and 8 disc sizes, weighing 190kg, 125kg, 110kg, and 92kg respectively. Capacity ranges from 350-650kg/day, according to the size of the thresher.

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalganj, Kanpur, U.P.
INDIA





VOTEX RICE FAN

The Votex Rice Fan comprises 30 fan blades and 6 beater bars, collecting trays enabling easy bagging, and a simple v-belt drive suitable for any petrol engine of 3.5-5hp. The Rice Fan can also be fitted with a diesel engine. In this case, a detachable sub-frame, with silent blocks to absorb the extra vibration, and an engine guard can be supplied. The overall weight of the standard model is 127kg; the diesel model weighs 200kg. Although, as its name suggests, the Votex Rice Fan was developed as a rice thresher, with minimal adjustments it can also be used for threshing various other crops such as wheat, barley, oats, cowpeas, sorghum and soybeans.

VOGELENZANG ANDELST B.V.
Postbus 1, 6673 ZG Andelst
Wageningsestraat 30, 6673 DD
HOLLAND

WATKINS NAYLER & CO. LTD.
Friars Street, Hereford
U.K.

ATS MIDGET THRESHER MKII A

Suitable for threshing wheat, barley, oats, beans, peas, sorghum, maize and rice, the Midget consists of a 6 beater, rasp bar drum with sealed bearings. The construction is of heavy plate with a lightweight feed chute and discharge hood over a simple fixed grid straw separator and grain chute. The power required is 3hp and capacity is up to 500kg/h for dry wheat. The overall weight is 127kg. Various concave attachments are available for maize, groundnuts and sorghum, including an extra pulley to reduce the drum speed. A screen separator is also available. Alvan Blanch produce a wide range of threshers, including the larger Master Midget which can be used as a peg drum thresher as well as a rasp bar, making it ideal for threshing high quality rice.

ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.

IRRI PORTABLE THRESHER TH6

The IRRI portable thresher consists of a metal frame, a pegtooth cylinder with straw throwing paddles on one end and enclosed by a cover with spiral louvres, and a wire mesh or round rod lower concave. A feeding tray, fan for winnowing, removable handle bars for transport and a 5hp petrol engine complete the unit.

Material is loaded onto the tray and fed into the opening between the cylinder and the lower concave. The pegs from the threshing cylinder hit the material, separating the grain from the straw, and at the same time accelerating them around the cylinder. The majority of the grain is threshed during the initial impact but further threshing is performed while the material moves axially until the straw is discharged at the opposite end. Threshed grain including impurities such as leaves and short pieces of straw, pass through the openings in the lower concave where it is cleaned by the winnowing fan. Threshing and separation losses are minimized by the cut-off wall installed at the end of the lower concave next to the straw thrower and by the stripper bars opposite the feed opening. The cut-off wall prevents grain from going into the straw thrower while the bars cut long straw for ease in axial movement and prevent straw from wrapping around the cylinder during threshing.

Some models of this thresher provide a door in the top cover for hold-on threshing. This threshing method is used in areas where the straw is used for mat and basket weaving. The door is raised and locked in place thereby exposing the entire cylinder length to hold-on threshing.

- power: 5hp engine
- weight (with engine): 105kg
- length: 95cm
- width (with feed tray folded): 76cm
- height (with feed tray folded): 138cm
- capacity: up to 600kg/h (rough rice)
- separation recovery: 98% (weight basis)
- grain purity (without cleaning screen): 94%
- grain breakage: less than 2%
- cylinder: pegtooth, 30.5cm O.D. 71.1cm length
- construction: all steel
- cylinder: 600-630rpm
- fan: engine speed
- labour requirement: 2-3 men
- fuel consumption (approx): 1 litre/h

BORJA MACHINE SHOP
Sgt. de Roma St.
San Pablo City, Laguna
PHILIPPINES

C & B CRAFTS
Maginao, San Rafael, Bulacan
PHILIPPINES

FRECOSA METALCRAFT
San Juan, Calamba, Laguna
PHILIPPINES

GINTONG ANI METALWORKS
Cainta, Metro Manila
PHILIPPINES

ISAROG INDUSTRIES
826 Renacimiento St., Tabuco
Naga City, Camarines Sur
PHILIPPINES

JCCE INDUSTRIES
242 Mayondon
Los Banos, Laguna
PHILIPPINES

KATO INTERNATIONAL
92 P. Santiago Street, Malinta
Valenzuela, Metro Manila
PHILIPPINES

KAUNLARAN INDUSTRIES
Calamba, Laguna
PHILIPPINES

L.P. ENGINEERING SERVICES
San Jose, Baliwag, Bulacan
PHILIPPINES

MECHANICAL FACTORS INC.
Ground Floor
Greenhills Dev. Bldg.
710 Shaw Blvd. Mandaluyong
Metroi Manila
PHILIPPINES

P.I. FARM PRODUCTS
KM 16, Malanday, Valenzuela
Metro Manila
PHILIPPINES

POYING'S WELDING SHOP
262 National Hi-Way
Brgy. Anos, Los Banos, Laguna
PHILIPPINES

SABIO AGRICULTURAL EQUIPMENT
Magarao, Camarines Sur
PHILIPPINES

TECHNO-ADAPTORS INC.
San Isidro
San Fernando, Pampanga
PHILIPPINES

A1 ENTERPRISES
Luna St., La Paz, Iloilo City
PHILIPPINES

APEX FARMERS' SUPPLY
143 Burgos St., Tacloban City
Leyte
PHILIPPINES

BETSY MARKETING
Huervana St., La Paz
Iloilo City
PHILIPPINES

CARVEL ENGINEERING WORKS
Km. 1, Roxas City, Capiz
PHILIPPINES

JAMANDRE INDUSTRIES
88 Rizal St., La Paz
Iloilo City
PHILIPPINES

JASPE METALCRAFT
Evangelista St., Pavia
Iloilo City
PHILIPPINES

MB ENTERPRISES
IPSTA Bldg. La Paz
Iloilo City
PHILIPPINES

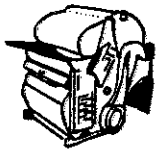
V&L AGRICULTURAL MACHINERY
Rizal St., La Paz
Iloilo City
PHILIPPINES

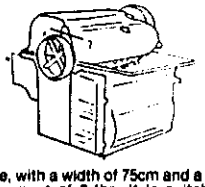
PETE LIMS ENTERPRISES
San Francisco, Agusan del Sur
PHILIPPINES

TRYME AGRO-INDUSTRIES
Lumbia, Pagadian City
PHILIPPINES

ALPHA MACHINERY & ENGINEERING CORP.
P.O. Box 579 MCC
Makati, Metro Manila, D708
PHILIPPINES

F. BUENACOSA REPAIR SHOP
Tacurong, Sultan Kudarat
PHILIPPINES



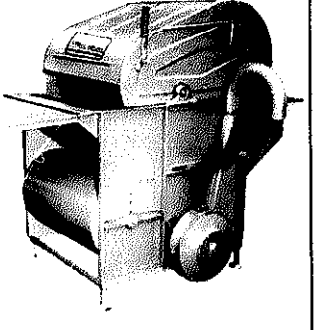


CECOCO THRESHERS

POWER THRESHER The Cecoco power thresher (illustrated above left) is available in three sizes. The L-15 requires 0.5hp, and has a capacity of 300-350kg/h. It has a width of 45cm. The L-18 is 54cm wide, with a capacity of 400-450kg/h and a power requirement of 0.5hp. The L-20 is 60cm wide, and has a capacity of 500-550 kg/h and a power requirement of 1hp.

UNIVERSAL THRESHER The universal thresher (illustrated above right) is a larger model than the power thresher above, with a width of 75cm and a power requirement of 2-4hp. It is suitable for threshing various kinds of beans and other pulses, rice and wheat, and features interchangable screens for different sizes of grain. The speed can be adjusted by changing the V-belt pulleys between the threshing drum and winnower. The universal thresher has a capacity of 1500kg/h for beans, and an overall weight of 120kg.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

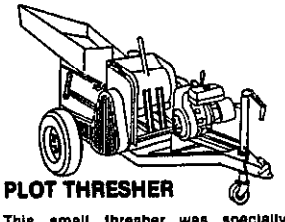


AKSHAT AND AMUDA SEMI-AUTO THRESHERS

American Spring and Pressing Works and Rajan Universal Exports both produce a similar semi-auto, multipurpose thresher. It consists of a threshing chamber, separator, dust discharging device, and a grain conveying and elevating mechanism. The threshing chamber contains a drum with 40 steel wire loops and a concave grill. The heads of grain are inserted into the threshing chamber, where the revolving drum combs out the grain which falls through the grill into the winnowing chamber. Clean grain is raised by the elevator for bagging. The semi-auto thresher has a power requirement of 2hp and a capacity of 200kg/h (rice).

AMERICAN SPRING & PRESSING WORKS PVT. LTD.
P.O. Box 7602
Adarsh Housing Society Road
Malad, Bombay 400 064
INDIA

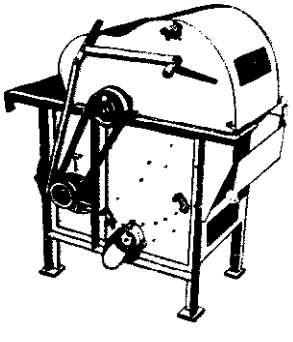
RAJAN UNIVERSAL EXPORTS (MFRS.) PVT. LTD.
'Raj Buildings'
162 Linghi Chetty Street
Post Bag 250, Madras 600 001
INDIA



PLOT THRESHER

This small thresher was specially developed for threshing different grains in experimental plots. It incorporates a special air device which enables the operator to adjust the air flow ensuring efficient separation of the chaff from the seed. The engine requires 7hp, and the overall weight is 480kg. The thresher is equipped with two tyred wheels and tow bar.

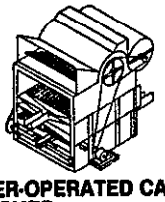
SWANSON MACHINE CO.
20-26 E. Columbia Avenue
Champaign, Illinois 61820
U.S.A.



BENAGRO PADDY-CUM-WHEAT THRESHER 5PW

This machine consists of an all-steel body fitted with a threshing cylinder, screw grain conveyor and a winnower for cleaning. It has an extra threshing bar attachment and blower driver pulley for wheat and paddy. The crop bundle is held with both hands and the heads inserted between the rotating cylinder loops and the concave screen. The separated grain falls through the screen and is cleaned by the winnowing action of air from the blower. The clean grains are finally delivered by means of the screw conveyor to the bag attached to the delivery spout. This machine has a power requirement of 3hp (electric motor) or 5hp (engine), and a capacity of 100-250kg/h for paddy, and 80-125kg/h for wheat.

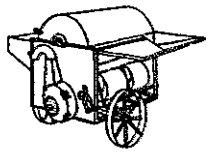
WEST BENGAL AGRO-INDUSTRIES CORPORATION LTD.
238 Netaji Subhas Road
3rd Floor, Calcutta 700 001
INDIA



POWER-OPERATED CASTOR THRESHER

Consisting of a teak wood cylinder and concave, a feed hopper, a blower, and a 3-sieve assembly. The perforated sheet at the bottom allows sand particles, weed seeds etc. to be sieved out of the shelled castor beans.

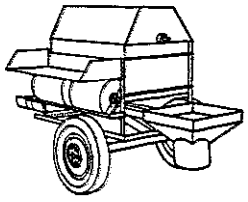
ANDHRA PRADESH AGRICULTURAL UNIVERSITY
Rajendranagar
Hyderabad 500 030
INDIA



MULTICROP AXIAL FLOW THRESHER

This is an all-steel, general-purpose thresher suitable for paddy, wheat, sorghum, bajra, soybeans and other small grain or pulse crops. It requires 5-7hp (petrol engine) and has a capacity ranging from 300kg/h for wheat to 600kg/h for sorghum. Overall weight (excluding engine) is approx. 320kg.

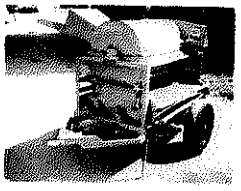
AMERICAN SPRING & PRESSING WORKS PVT. LTD.
P.O. Box 7602
Adarsh Housing Society Road
Malad, Bombay 400 064
INDIA



LAKSHMI AXIAL FLOW THRESHER

Suitable for a variety of grains, the Lakshmi thresher combines threshing and winnowing. It has a power requirement of 7hp and a capacity of up to 900-1000kg/h for paddy.

P.M. MADURAI MOODALIAR & SONS
Madurai Moodaliar Road
Postbox 7158, Bangalore 560 053
INDIA



STANDARD AXIAL FLOW THRESHER

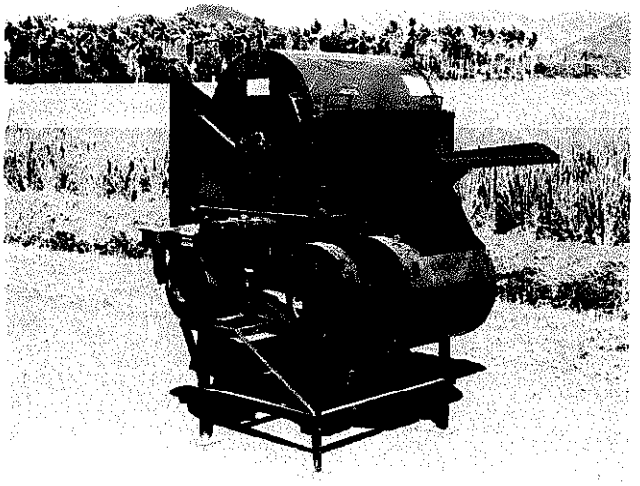
The Standard axial flow thresher (illustrated) has a power requirement of 10hp. It is suitable for a variety of crops and can be easily converted into a maize sheller. Capacity ranges from 800kg/h for paddy to 2500kg/h for sorghum.

UNION TRACTOR WORKSHOP
6-B Phase 11
Maya puri Industrial Area
New Delhi 110 064
INDIA

IRRI AXIAL FLOW THRESHERS TH7 & TH8

These threshers are essentially large versions of the TH6 axial flow thresher. They are heavier and hence are mounted on a wheeled chassis. The specifications are:

- power: 7hp engine
- weight (with engine): 430kg
- length: 258.45cm
- width: 130.18cm
- height
  with wheel: 158.12cm
  without wheel: 111.76cm
- separation recovery: 98% (weight basis)
- cylinder: spiketooth 39.8cm O.D. × 122.0cm length
- construction: all steel
- component speeds
  cylinder: 500-530rpm
  fan: 1030rpm
- oscillating screen: 334-354 cycles/min
- oscillating screen (stroke): 0.925cm
- adjustments: angle of air deflector and engine speed.



ALPHA MACHINERY & ENGINEERING CORP.
P.O. Box 579 MCC
Makati, Metro Manila, D708
PHILIPPINES

C & B CRAFTS
Maginao, San Rafael, Bulacan
PHILIPPINES

FRECOSA METALCRAFT
San Juan, Calamba, Laguna
PHILIPPINES

JCCE INDUSTRIES
242 Mayondon
Los Banos, Laguna
PHILIPPINES

KASAGANAAN INDUSTRIES
San Jose, Mindoro Occidental
PHILIPPINES

L.P. ENGINEERING SERVICES
San Jose, Baliwag, Bulacan
PHILIPPINES

MECHANICAL FACTORS INC.
Ground Floor
Greenhills Dev. Bldg.
710 Shaw Blvd. Mandaluyong
Metro Manila
PHILIPPINES

P.M. MADURAI MOODALIAR & SONS
Madurai Moodaliar Road
Postbox 7156
Bangalore 560 053
INDIA

NIBROS MANUFACTURING CORP.
Dona Rosario Heights
Novaliches, Metro Manila
PHILIPPINES

P.I. FARM PRODUCTS
KM 16, Malanday
Valenzuela, Metro Manila
PHILIPPINES

POYING'S WELDING SHOP
262 National Hi-Way
Brgy. Anos, Los Banos, Laguna
PHILIPPINES

TECHNO-ADAPTORS INC.
San Isidro
San Fernando, Pampanga
PHILIPPINES

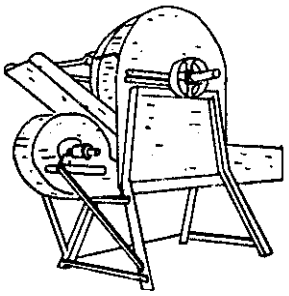
JAMANDRE INDUSTRIES
88 Rizal St., La Paz
Iloilo City
PHILIPPINES

VICMAC CORPORATION
Mandalagan, Bacolod City
Negros Occidental
PHILIPPINES

KATO INTERNATIONAL
92 P. Santiago, Malinta
Valenzuela, Metro Manila
PHILIPPINES

KAUNLARAN INDUSTRIES
Calamba, Laguna
PHILIPPINES

DRUMMY THRESHERS



HIRA THRESHER Fitted with a threshing drum and a fan, this thresher (illustrated left) is available in 4 sizes, ranging from 3-10hp. With the largest model, capacity can reach 4000kg/h.

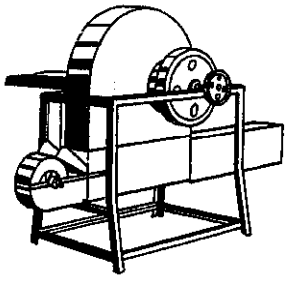
INTERNATIONAL MFG. CO. (REGD.)
Hospital Road, Jagraon
Ludhiana, Punjab
INDIA

MACO WHEAT DRUMMY THRESHER Three models (illustrated right) are available, with power requirements of 5, 7.5 and 10hp.

MOHINDER & CO. ALLIED INDUSTRIES
Kurali, Distt. Ropar, Punjab
INDIA

K.I.W. DRUMMY TYPE THRESHER Available in a range of models, from 5-15hp.

KHALSA IRON WORKS
2015 Railway Road
Narela, Delhi 110 040
INDIA



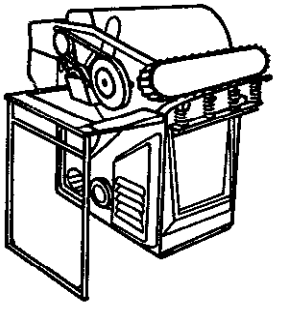
JYOTI THRESHERS

WHEAT THRESHER This machine (illustrated) can be adapted for crops other than wheat, by changing the required screens and pulleys. Power requirement is 7.5hp and capacity ranges from 300-500kg/h for wheat, to 1300-1600kg/h for jowar. Overall weight is 535kg.

MULTI-CROP THRESHERS Suitable for all types of grain, this is a light machine with a power requirement of 3hp and a capacity of 150-200kg/h for wheat, 500-800kg/h for jowar. Overall weight is 250kg.

PADDY THRESHER The power required is 5hp and capacity ranges from 300-400kg/h for wheat, to 600-1000kg/h for jowar. Overall weight is 530kg.

JYOTI LTD
Bombay Shopping Centre
R.C. Dutt Road
Vadodara 390 005
INDIA



CHINESE AND KOREAN THRESHERS

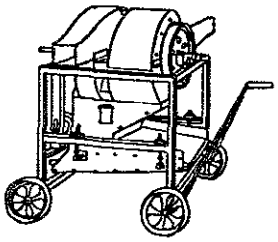
WP400 THRESHER This small machine (illustrated) is designed primarily for threshing rice and wheat. It has a capacity of 350-750kg/h for wheat and 600-1000kg/h for rice, and a power requirement of 5hp.

Manufactured by the Zhing Jan Thresher Factory and available through:

CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing
CHINA

KOREAN AUTOMATIC THRESHERS Four models are produced in Korea, with a power requirement of 3-5hp. Capacity ranges from 1200kg/h for the smaller models, to 1400kg/h for the larger models.

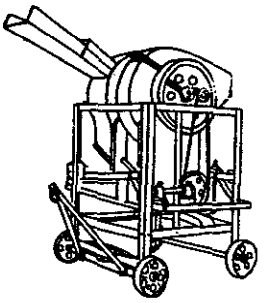
KOREA TRADE PROMOTION CORPORATION
C.P.O. Box 1621, Seoul
KOREA



MULTI-CROP THRESHER

Threshes wheat, bajra, jawar and other crops with minimum grain loss and breakage. Power required 5hp. Capacity 3-4 quintals/h at 820rpm.

DANDEKAR BROTHERS
Sangli-Shivaji Nagar, 416 416
Maharashtra
INDIA



POWER THRESHERS

AJANTA MULTIPURPOSE THRESHER Several models are available, ranging from 5-50hp. It has tempered adjustable treaded spikes and an adjustable air flow. (Illustrated left).

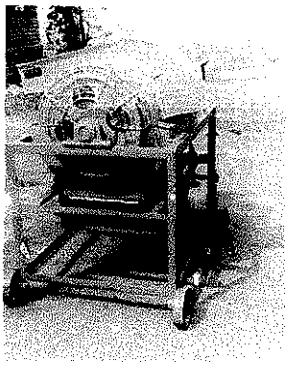
MOHAN SINGH HARBHAJAN SINGH
G.T. Road,
Goraya 144 409 (Pb.) Distt.
Jullundur (N.R.)
INDIA

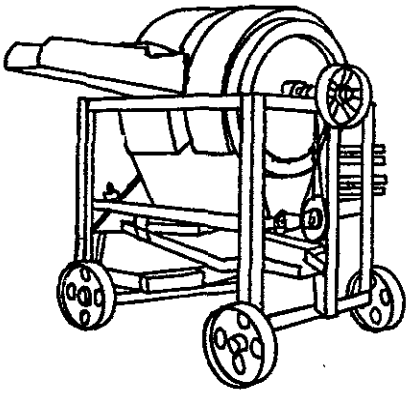
K.I.W NEW-TYPE THRESHER WINNOWER

KHALSA IRON WORKS
2015 Railway Road
Narela, Delhi 110 040, INDIA

UT SONA WHEAT THRESHER This thresher (illustrated right) has a power requirement of 10hp, and capacity of 300 kg/h.

UNION TRACTOR WORKSHOP
8-B Phase 11
Maya puri Industrial Area
New Delhi 110 064, INDIA





ROTOR THRESHERS

ROTOR TYPE WHEAT THRESHER This machine (illustrated) is fitted with a spike-tooth threshing drum, and is suitable for threshing a variety of grains. Three models are available, with power requirements of 3-7.5hp, and capacities ranging from 1-4 quintals/h for wheat, to 3-7 quintals/h for jawar.

STANDARD AGRICULTURAL ENGINEERING CO.
824 & 825 Industrial Area B
Ludhiana A-141 003, Punjab
INDIA

MULTIPURPOSE THRESHER Four models are available, with power requirements of 3-10hp.

AMAR AGRICULTURAL IMPLEMENTS WORKS
Amar Street, Gill Road
Janta Nagar, Ludhiana-141003
INDIA

MACO ROTOR TYPE POWER WHEAT THRESHERS These threshers, ranging from 3-15hp, are suitable for threshing wheat, jowar, bajra, sorghum, barley etc.

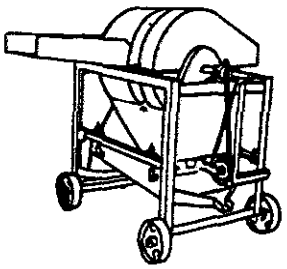
MOHINDER & CO. ALLIED INDUSTRIES
Kurali, Distt. Ropar, Punjab
INDIA

WHEAT THRESHING AND WINNOWING MACHINE Again, a series of models is available, with power requirements of 5-15hp, and capacity ranging from 2-7 quintals/h.

ALLIED TRADING COMPANY (INDIA)
Railway Road
Ambala City, Haryana
INDIA

HIRA THRESHER AUTOMATIC The Hira automatic comprises a peg type drum, a suction fan and two sieves. Specifications are similar to those of the Allied thresher above.

INTERNATIONAL MFG. CO. (Regd.)
Hospital Road, Jagraon
Ludhiana, Punjab
INDIA

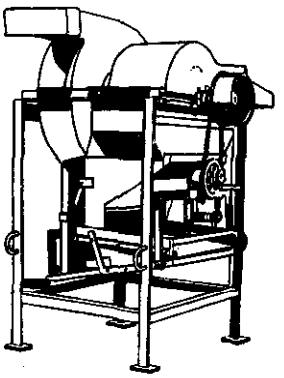


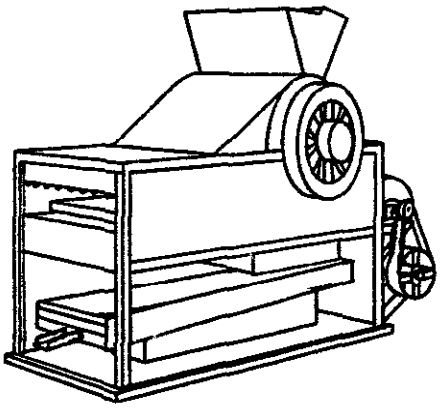
SHERPUR THRESHERS

SHERPUR POWER THRESHER WINNOWER This is a versatile machine (illustrated left) suitable for threshing crops such as wheat, barley, millet, soybean, mustard etc. It consists of a spike-tooth cylinder with steel bolts, and a concave mechanism. The cylinder speed for threshing particular crops can be altered either by adjusting the speed of the prime mover, or by the provision of a pulley. Separation of the grain from the straw is achieved by an aspirator and a set of oscillating sieves. The speed of the aspirator and that of the sieves is adjustable. The thresher winnower can be operated with a 5-25hp motor or engine

SHERPUR PADDY THRESHER Designed for threshing both wet and dry paddy, the machine (illustrated right) comprises a spike-tooth cylinder, a concave mechanism and a blower. It has a power requirement of 10-20hp. Capacity ranges from 6-8 quintals/h (using 10hp motor) up to 10-12 quintals/h (using 20hp motor).

UNION FORGINGS
Sherpur, Ludhiana, Punjab
INDIA





PADDY THRESHERS

KERTA LAKSANA PADDY THRESHER This machine (illustrated) is constructed of steel plate and is designed for threshing paddy. It consists of a threshing drum with spike tooth cylinder, a separator fan, and a swinging sieve at the bottom. It has a power requirement of 4hp and a capacity of 400-500kg/h. Overall weight is 225kg.

P.T. KERTA LAKSANA
Jl. Jenderal Sudirman 504
Bandung
INDONESIA

BUMA SAKTI PADDY THRESHER An all-steel paddy thresher with a capacity of 300-600kg/h. It can be powered by electric motor or diesel engine. Overall weight is 105kg.

P.T. BUMA SAKTI
Jl. Suriani 5, Bandung
INDONESIA

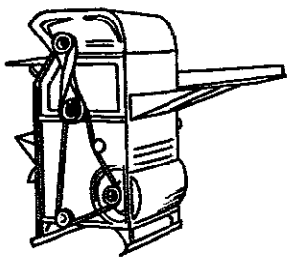
THRESHERS

BENAGRO POWER-OPERATED WHEAT THRESHER 510 This thresher (illustrated) comprises an all-steel body, fitted with a peg-type threshing cylinder, centrifugal blower assembly, and top and bottom shaker unit. It has a power requirement of 3hp (electric motor) or 5-10hp (diesel engine). Overall weight is 230kg.

WEST BENGAL AGRO-INDUSTRIES CORPORATION LTD.
23B Netaji Subhas Road
3rd Floor, Calcutta 700 001
INDIA

KISAN POWER PADDY THRESHER This is a similar machine for threshing paddy and has a capacity of 300-600kg/h of paddy.

KISAN KRISHI YANTRA UDYOG
34 Moti Bhawan, Collectorganj
Kanpur 208 001
INDIA



TB60 DOUBLE THRESHER

The TB60 thresher has double husking rollers and knife-shaped gears. The knife-shaped gears fixed onto the rotating rollers interact with bow-shaped gears fixed onto the concave board in order to comb and thresh the grains. The threshed grain falls through the gaps while the stalks are thrown upwards by the rotary action of the roll bar. The TB60 has a power requirement of 6-8hp (diesel engine) and 6-7hp (electric motor). It has a capacity of 400-600kg/h for wheat, and 800-1200kg/h for rice, and is suitable for threshing all kinds of large grains. The overall weight is 235kg.

CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street
Beijing
CHINA

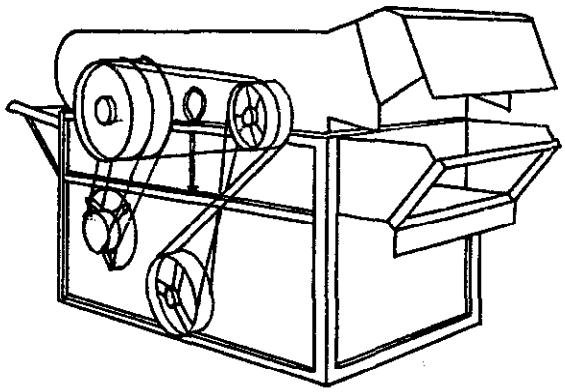
THRESHERS

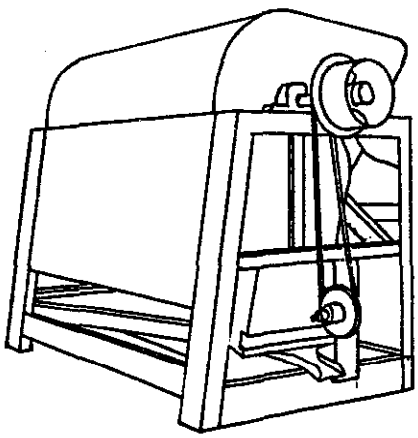
YANMAR DOUBLE DRUM PADDY THRESHER This rasp bar thresher has a power requirement of 7hp and a capacity of 900-1000kg/h. It weighs 169kg.

P.T. YANMAR AGRI M/G (P.T. YAMINDO)
42 Jl. Ir.H. Juanda
P.O. Box 4135/JKT, Jakarta
INDONESIA

AR 500 A AND AR 1000 A Both threshers have two rasp bar threshing drums. Power requirement is 5 and 8-10hp, capacity 500kg/h and 1000kg/h respectively. The AR 500 A weighs 113kg, the AR 1000 A, 177.5kg.

P.T. AGRINDO
Desa Bambe Kab. Gresik,
Jawa, Timur
INDONESIA



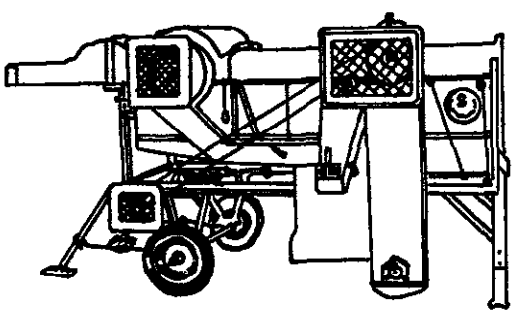


MADHO WHEAT THRESHERS

Madho produce a range of wheat threshers which are also suitable for threshing other crops such as barley, jowar, bajra, pulses etc. It performs the threshing, screening and winnowing processes in one operation.
Technical specifications:

Model	Electric motor hp	Oil engine hp	Output kg/h
1	5	5-8	200
2	7.5	10	300
3	10	12-15	500
4	15	20	600-700
5	20	25	800

MADHO MECHANICAL WORKS
B-49 Industrial Focal Point
G.T. Road
Moga 142 001 (Punjab)
INDIA

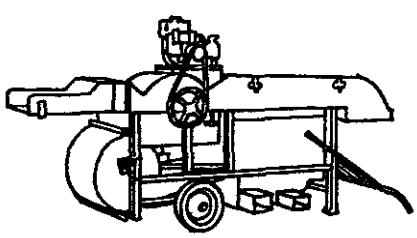


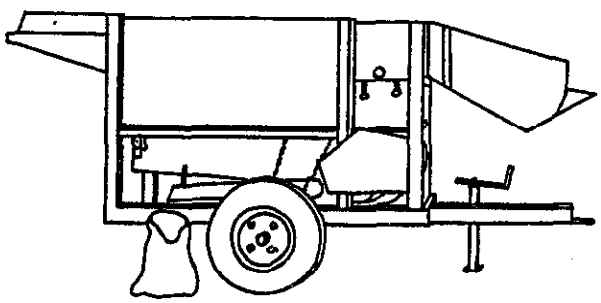
STANDARD THRESHERS

STANDARD UNIVERSAL THRESHER RD IVa This machine (illustrated above) is suitable for threshing all cereals. It consists of a peg-threshing drum and adjustable concaves. It has a power requirement of 5-8hp, and an overall weight of 470kg.

STANDARD RICE THRESHER IIa Adaptable for hand, foot or motor drive, this thresher is equipped with a toothed drum and toothed concave. It does not have a cleaner and straw shaker attachments. Power requirement is 3-5 hp, and overall weight is 330kg. (illustrated below).

STANDARD GmbH
Postfach 1160
3118 Bad Bevensen
W. GERMANY





MOBILE THRESHERS

AMAR MULTICROP THRESHER This is a raspbar thresher suitable for all cereals, soybeans etc. It requires 10hp, and has a capacity of 6-10 quintals/h for wheat, and 25-35 quintals/h for maize. The overall weight is 640kg.

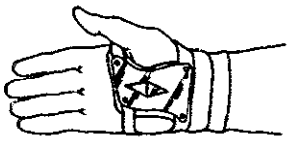
AMAR AGRICULTURAL IMPLEMENTS WORKS
Amar Street, Gill Road
Janta Nagar, Ludhiana-141003
INDIA

VICON THRESHER ST-45 The ST-45 is fitted with a rasp bar drum, and can be equipped with wheels for trailing, or a yoke for bullock draught. It has a power requirement of 10hp, and a capacity ranging from 1000kg/h for wheat, to 2000kg/h for maize. The overall weight is 790kg.

VICON LTD.
K.R. Puram — Whitefield Road
Mahadevapura Post
Bangalore 560 048, Karnataka
INDIA

MINORETTE AND MINOR THRESHERS The minorette (illustrated) has a power requirement of 7.5hp. It can be fitted with either a peg drum, consisting of 12 bars each with 5 pegs, or a rasp bar drum, consisting of 8 beaters. The overall weight is 900kg. Capacity, based on average dry wheat, can reach 1000kg/h. The Minor is a larger thresher weighing 1400kg. Like the minorette it can be fitted with a rasp bar or a peg drum. Capacity can reach 2000kg/h. The minor thresher features a grain elevator consisting of a bucket and roller chain with single bagging-off chute. It is constructed from steel and mounted on a robust steel chassis.

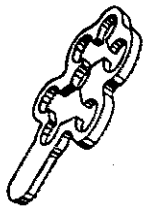
ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.



HUSKING HOOKS AND PINS

These husking hooks greatly speed the laborious task of removing the husk from corn cobs when this is carried out as a manual operation. When harvesting, too, is manual the husk is often left on the stem.

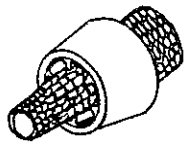
MAST HARNESS SHOP
Rt. 1, Box 228
Harlatown, Iowa 50841
U.S.A.



DUPLEX HAND-HELD MAIZE SHELLER

A simple, highly efficient hand-held sheller with the capacity to handle cobs of varying size. It is manufactured in cast iron for long life. Two sizes are available.

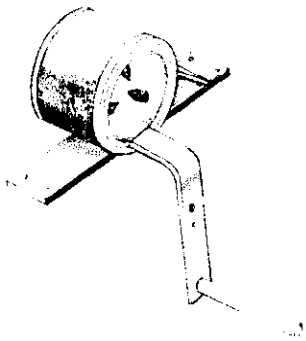
R. HUNT & CO. LTD.
Atlas Works, Earls Colne
Colchester, Essex CO6 2EP
U.K.

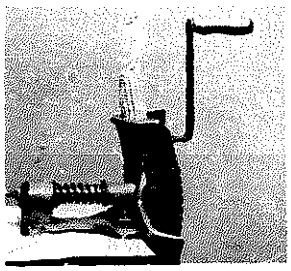


HAND CORN SHELLER AND SEED GRADER

This sheller ensures quick and easy shelling of corn. It is especially adapted for use in the selection of seed corn, as it does not break off the germ ends of the kernels.

DECKER MANUFACTURING COMPANY
312 Blondeau, Keokuk
Iowa 52632
U.S.A.





HAND-OPERATED MAIZE SHELLERS

The following firms manufacture a hand-operated maize sheller designed for bench mounting. Capacity may reach 500 cobs/h.

HAND-OPERATED SHELLER (illustrated)

ETS. A. GAUBERT
22 rue Gambetta
BP 24, 16700 Ruffec
FRANCE

MAIZE SHELLER NO. 994 Electrically moulded cast iron. Weight 4.5kg.

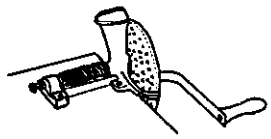
LANG FERRY & CIE
Brousseval (Mte-Marne)
52130 Wassy
FRANCE

SHELLER Cast iron body, steel crank with movable toothed disc on steel shaft with compression spring. Weight 6kg.

RENSON ET CIE
BP 23, 59550 Landrecies
FRANCE

MAIZE DECORTICATOR E 220 Spring assembly allows all sizes of corn cob to pass through. Weight 6kg.

S.E.C.A.
38260 La Cote St. André
FRANCE



AB/MSHB MAIZE SHELLER

This sheller is illustrated above. Cast iron stripper plate is spring loaded to accept cobs of any size.

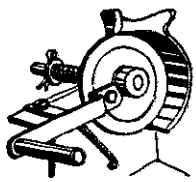
ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.

CHITETZE HAND-OPERATED MAIZE SHELLER

This sheller comprises two steel cylinders. The inner cylinder, fitted with two rows of internal teeth, is revolved within the outer by a hand crank. The sheller can be attached to any convenient wooden surface by nails or screws. The shellers are made in three sizes to suit the principle maize varieties grown in Malawi. The sizes relate to the circle formed by the ends of the teeth, and are 40mm, 33mm and 27mm respectively. The sheller has an output of 30kg/h of shelled maize from dehusked cobs.

PETROLEUM SERVICES (MALAWI) LTD.
Barnes Rd., Ginnery Corner
P.O. Box 1900, Blantyre
MALAWI

LILONGWE SHEET METAL LTD.
P.O. Box 47
Kanengo, Lilongwe 4
MALAWI



NDUME HAND-OPERATED MAIZE SHELLER

Constructed of three basic parts, of which two are strong and durable castings, the Ndume maize sheller is simple and robust. It can be mounted on a bench, table or post, and has a capacity of approximately 30kg/h of maize.

NDUME PRODUCTS LTD.
P.O. Box 62, Gilgil
KENYA

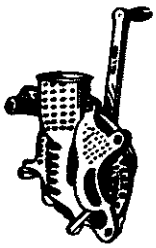
HAND-OPERATED MAIZE SHELLERS

ATLAS SHELLER Manufactured in the traditional design, this maize sheller (illustrated left) is constructed from cast iron for durability and long life. The Atlas maize sheller has a capacity of up to 120kg/h.

R. HUNT & CO. LTD.
Atlas Works, Earls Colne
Colchester, Essex CO6 2EP
U.K.

SMALL MAIZE SHELLER The small maize sheller (illustrated right) is designed so as not to break the eye of the corn seed, which is essential for germination. It has a capacity of 30-50kg/h of grain, and an overall weight of 20kg.

MOHAN SINGH HARBHAJAN SINGH
G.T. Road
Goraya 144 409 (Pb.) Distt.
Jullundur (N.R.)
INDIA



HAND MAIZE SHELLERS

The following manufacturers all produce a spring maize sheller, with an average weight of 7kg.

They can be mounted on a stand, bench, box etc. and have an output of 30-100kg/h.

RAJAN UNIVERSAL EXPORTS (Mfrs.) PVT. LTD.
Post Bag 250, Madras 600 001
INDIA

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

DANDEKAR BROTHERS
Sangli-Shivaji Nagar, 416 416
Maharashtra
INDIA

IDEAL CASEMENTS (E.A.) LTD.
Box 45319, Nairobi
KENYA

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalganj, Kanpur, U.P.
INDIA

ALLIED TRADING COMPANY (INDIA)
Railway Road
Ambala City, Haryana
INDIA

CORN SHELLER

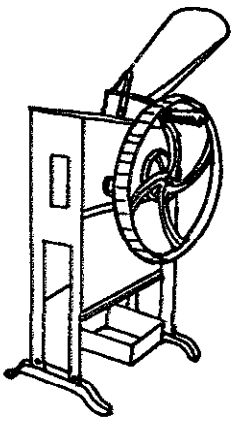
C.S. Bell produce this small corn sheller designed for dry ear maize and walnuts. It includes a cob ejector and tipping attachment. The spring adjusts to fit all size ears.

C.S. BELL CO.
170 W. Davis Street
Box 291, Tiffin, OH 44883
U.S.A.

MAIZE AND WALNUT SHELLER

A cast iron sheller weighing 10kg suitable for all types of large nuts, maize and corn.

CHAFF-CUTTERS (NZ) LTD.
P.O. Box 11, Ngatea
NEW ZEALAND



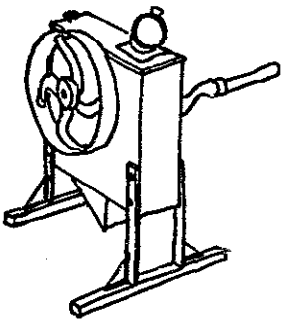
MAIZE SHELLERS

AB/MAH/3 MAIZE SHELLER This simple, hand-fed sheller (illustrated) has one hole to receive the cobs. It can be adapted for hand, pedal or power drive, the latter using a 0.5hp electric motor or petrol engine. Capacity, at 170rpm, is approx. 300kg/h. Overall weight is 86kg.

ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.

MOTORIZED MAIZE SHELLER Powered by 0.5hp motor, this sheller has a capacity of 300kg/h, although it can be driven by hand. The overall weight is 66kg.

RENSON ET CIE
BP 23, 59550 Landrecies
FRANCE



MAIZE SHELLERS

MAIZE SHELLER Hand- or motor-driven, with a capacity of 150-300kg/h (illustrated left).

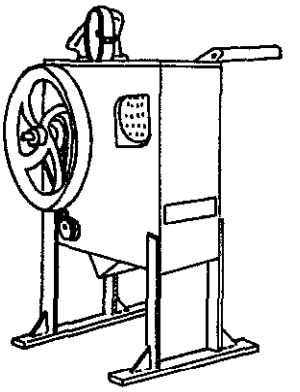
SISMAR
B.P. 3214
20 rue Dr. Theze, Dakar
SENEGAL

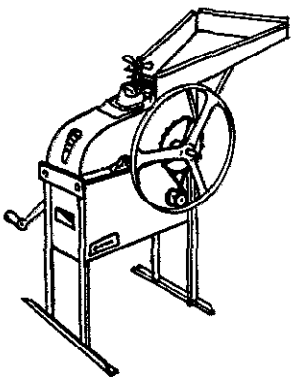
HAND-OPERATED CORN SHELLER This machine can be operated by hand or by an electric motor.

UNION FORGINGS
Sherpur, Ludhiana, Punjab
INDIA

MAIZE HULLER NO. 3 M The 3 M (illustrated right) is hand-operated only, *unlike the two models featured above.* It can be regulated for different sizes of cob by means of a wing nut. Capacity is approx. 300-400kg/h.

ETS. CHAMPENOIS S.A.
Chamouilley, 52170 Chevillon
FRANCE





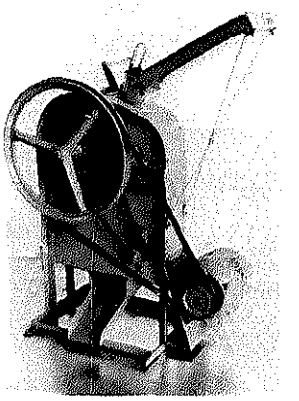
MAIZE SHELLERS

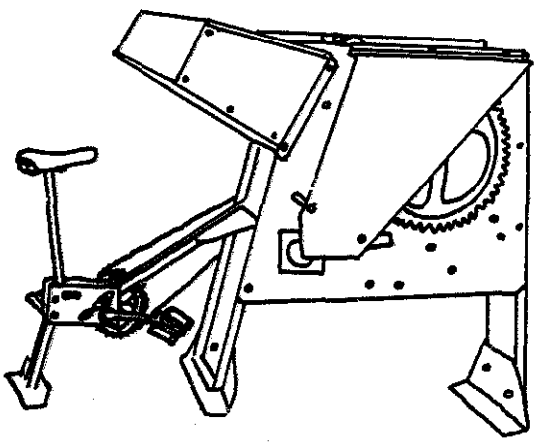
DM-2 CORN GRINDER This maize sheller (illustrated left) can be operated by hand or by a 0.25hp motor. It features a pressure lever regulated by a spring in order to adjust to various cob sizes, and a cleaning fan. Overall weight is 76kg.

PENAGOS HERMANOS & CIA. LTDA
Calle 28, No 20-80
Apartado Correos 689
Bucaramanga
COLOMBIA

HAND AND POWER MAIZE SHELLER A spring-type sheller (illustrated right) of all-steel construction with a cleaning fan. Power requirement is 1hp. Capacity ranges from 100-120kg/h (hand-operated) up to 200-300kg/h (power-operated). Overall weight is 70kg.

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA





CYCLE MAIZE SHELLERS

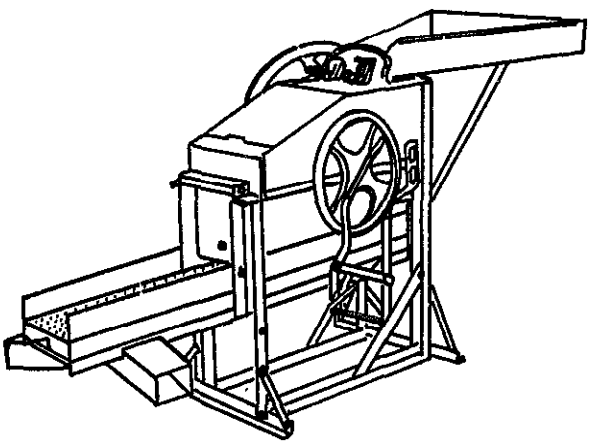
Individual cobs are fed by hand into two holes and then drawn against revolving vertically mounted plate wheels.

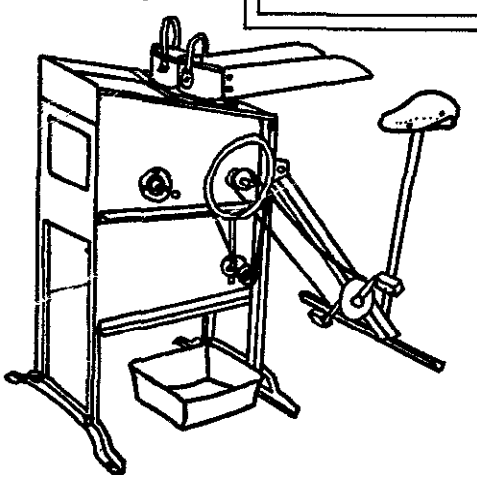
AB/MSH/8 MAIZE SHELLER This model (illustrated above) has no sieving action, *but a winnowing fan helps provide a* clean sample. It can be powered by a petrol engine or ½hp electric motor (output 800kg/h).

ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN 16 9SG
U.K.

COBMASTER MAIZE SHELLER This machine (illustrated right) can be hand- or pedal-operated or power driven (output up to 750kg/h).

R. HUNT & CO. LTD.
Atlas Works, Earls Colne
Colchester, Essex CO6 2EP
U.K.





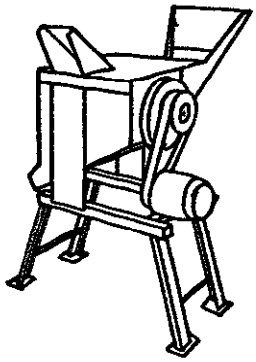
2-HOLE SHELLERS

The illustration above shows the 2-hole sheller which will give two grades of maize. It has the following features:

- hand powered
- output of up to 10 bags per hour
- metal construction for durability
- grades into two grades
- adjustable for cob size
- lubricated roller bearings
- power pulley available

BAIN MANUFACTURING COMPANY (PVT.) LTD.
Box 1160, Harare
ZIMBABWE

JAMES NORTH & SONS LTD.
P.O. Box No. 3, Hyde
Cheshire SK14 1RL
U.K.



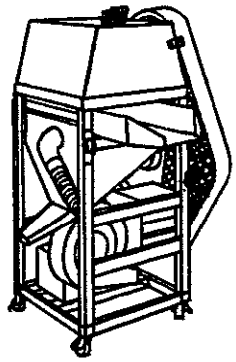
CORN HUSKER/SHELLER

CORN HUSKER SHELLER This machine is fitted with an axial flow motor capable of husking and shelling up to 600kg of maize per hour. It has a pneumatic box-winnowing system and is driven by a 2hp electric motor or engine. (illustrated).

LAREDO MODELS S.A.
Industria E. Comercio
Rua 1 de Agosto
17.100 Bauru (SP)
BRAZIL

CORN SHELLER Two models are produced for husking, cleaning and sacking of any kind of corn. They can be powered by tractor, electric motor or petrol or diesel engine. Model SDMN -15/35 is the smaller machine with a power requirement of 5 to 8hp. and output of 900 to 2100kg/h.

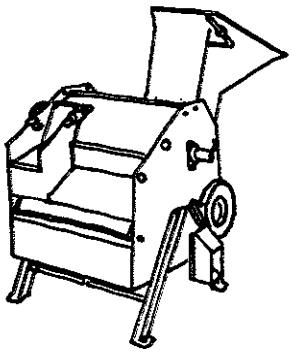
NOGUEIRA IRMAOS SA
Rua XV de Novembro 781
P.O. Box 7
13970 — 1 Itapira, Sao Paulo
BRAZIL



SINGLE-EAR SHELLER

The single-ear corn sheller was developed primarily for use on test plots. It enables the operator to grade, count and size corn more efficiently. It is equipped with two 110 volt electric motors. One drives the shelling and separating operation and the other the blower for cleaning. The shaker pan has oval screen openings to allow all sizes of seed to be cleaned. The sheller is well constructed of tubular steel and 16 gauge sheet metal. It is mounted on rolling castors that can be locked when in position. It has belt and chain guards for safety. The height of the sheller is 125cm which makes observation of operating procedure possible at all times.

SWANSON MACHINE CO.
20-26 E. Columbia Avenue
Champaign, Illinois 61820
U.S.A.

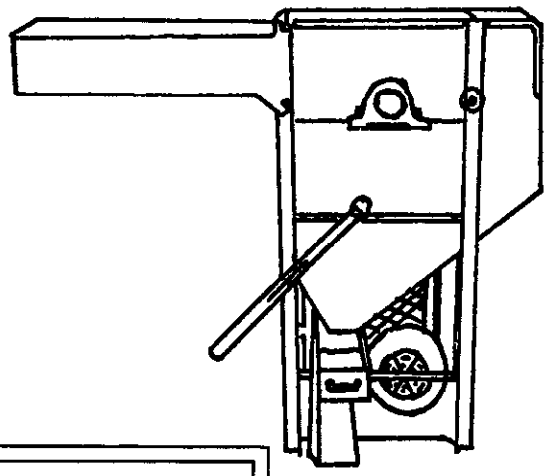


MAIZE SHELLER M30

The M30 maize sheller standard model (illustrated) is supplied with a 240mm diameter pulley and carrier arms. The power requirement is 3 to 5hp and output is 2000 to 3000kg/h. The following accessories can be fitted:

- bagging elevator, outlet at 0.9m from ground
- bulk elevator, outlet at 1.9m from ground
- 3 point linkage with Glaenzer joint drive and protector to enable the sheller to be driven by tractor
- electric motor with a 120mm diameter flat pulley and belt
- lengthening port 1m in length to extend the bulk elevator or bagging elevator.

STE COMIA-FAO SA
27 bd. de Châteaubriant, BP 91
35500 Vitré
FRANCE



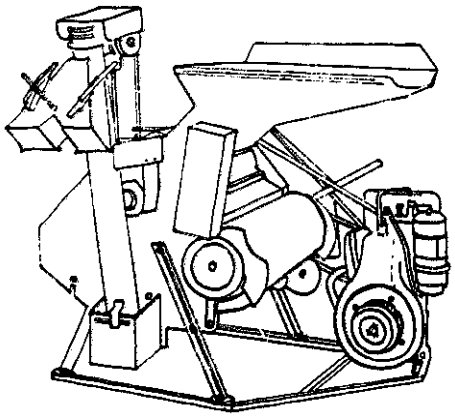
CORN SHELLERS

ALMACO EAR CORN SHELLER A self-cleaning unit with a rasp bar type shelling cylinder suitable for the grain breeder and similar research operations and is capable of single and multiple ear shelling. It requires a 2hp electric or 3hp petrol engine.

ALMACO
Box 298, 99 M. Avenue
Nevada, Iona 50201
U.S.A.

EDALTA 200 This corn sheller or steel construction can be powered by a 5 to 7hp petrol or diesel engine or a 3 or 4hp electric motor and produces up to 2100kg/h.

CIA PENHA MAQ. AGRICOLAS
Av. Brazil 1724, C.P. 477
Ribeirao preto
BRAZIL

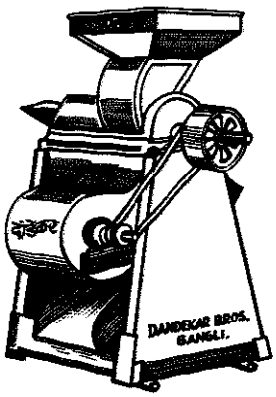


TROPICAL SHELLER

The Bamba tropical sheller is designed for African millet, sorghum and maize and can be operated by one person. It is powered by either a 5.5hp electric motor or 9hp petrol or diesel engine or with power take-off for any tractor. The output per hour is 1500kg of maize or 300-500kg of millet.

The grain can be collected in bags laid on the ground or the long auger can be attached for discharging directly into a trailer.

BOURGOIN S.A.
21 Av. Georges-Clemanceau
85110 Chantonnay, BP 17
FRANCE



MAIZE SHELLER

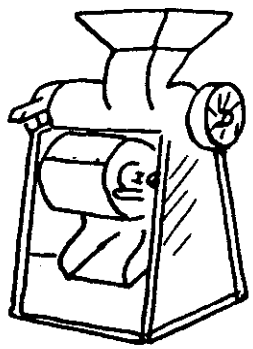
This machine (illustrated left) can either be hand-operated or power-operated, requiring a 5hp motor or engine. The shelling capacity is 1500kg/h.

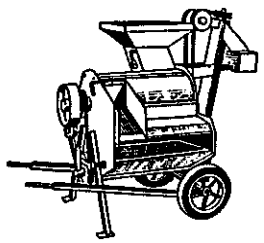
DANDEKAR BROTHERS
(Engineers & Founders)
Sangli-Shivaji Nagar, 416 416
Maharashtra
INDIA

POWER MAIZE SHELLER

Dry cobs are fed into the shelling drum through a chute. Rotating iron beaters shell the grain (illustrated right). The power requirement is 3 to 5hp and output in 2000 to 2500kg/h

INTERNATIONAL MFG. CO (Regd.)
Hospital Road, Jagraon
Ludhiana, Punjab
INDIA

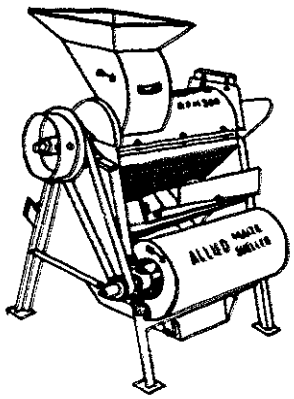




BAMBA CORN SHELLER

For millet, sorghum and maize, this machine requires an 8.5hp engine and has an hourly output of 300kg of millet or 1500kg of maize.

MARPEX
1 rue Thurot, 44000 Nantes
FRANCE



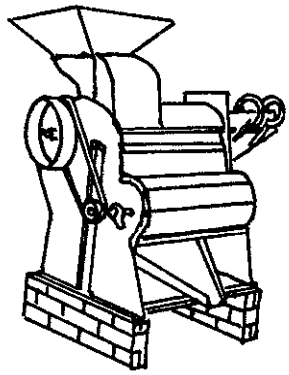
MAIZE SHELLERS

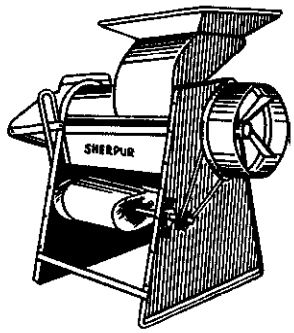
POWER-DRIVEN MAIZE SHELLER Operated with a 5hp electric motor, or with an oil engine (illustrated left). A winnowing fan is attached which separates the kernels from the cobs. The cobs are then expelled and the maize kernels are cleaned by the exhaust fan.

ALLIED TRADING COMPANY (INDIA)
Railway Road
Ambala City, Haryana
INDIA

MOHINDER MAIZE SHELLERS Mohinder produce two power-driven maize shellers (illustrated right). The first has a power requirement of 3hp and an output of 10-15 quintals/h. The second, larger model has a power requirement of 5hp and a capacity of 18-20 quintals/h.

MOHINDER & CO. ALLIED INDUSTRIES
Kurali, Distt. Ropar, Punjab
INDIA



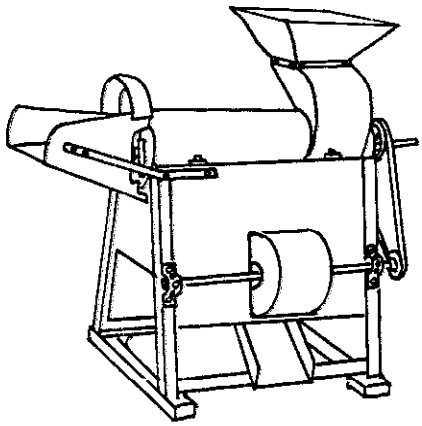


SHERPUR MAIZE SHELLERS

Both Union Forgings and Eicher produce the power-operated maize sheller illustrated above. It is manufactured from steel and can be operated with either an electric motor or a diesel engine. The power requirement is 5hp. Output ranges from 15-25 quintals/h of grain according to the rate of feeding. The overall weight of the Sherpur maize sheller is 200kg.

UNION FORGINGS
Focal Point
Sherpur, Ludhiana, Punjab
INDIA

EICHER GOODEARTH LTD.
Deepak 3rd Floor
13 Nehru Pl, New Delhi 110 019
INDIA



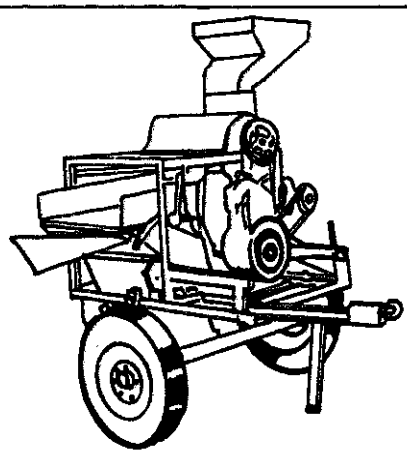
MAIZE SHELLERS

SPIKE-TOOTH MAIZE SHELLER This sheller features a blower for increased cleaning efficiency, and a lever to control the flow of grain. Two models are produced, the MS-10 and the MS-5, with power requirements of 10 and 15hp, and outputs of 15-25 and 10-15 quintals/h respectively. (Illustrated).

STANDARD AGRICULTURAL ENGINEERING CO.
824 & 825 Industrial Area B
Ludhiana A-141 003, Punjab
INDIA

AMUDA MAIZE SHELLER It can be powered by an electric motor or an oil engine. Again, two models are available, with power requirements of 3 and 5hp, and capacities of 1000-1200 and 1450-1650kg/h respectively.

RAJAN UNIVERSAL EXPORTS (MFRS.) PVT. LTD
Post Bag 250, Madras 600 001
INDIA

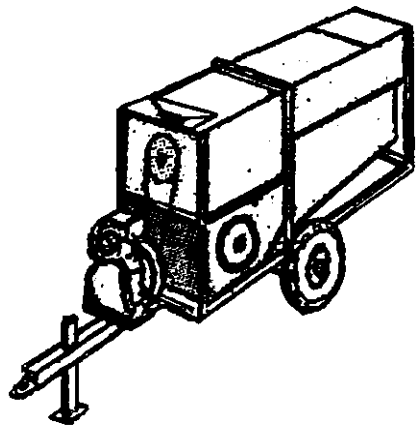


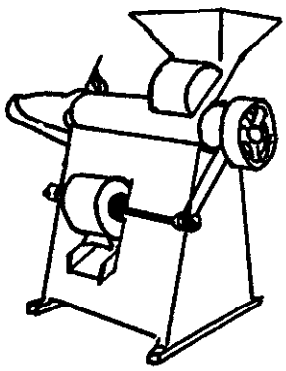
LAKAS KULIGLIG CORN SHELLER

The Lakas corn sheller has the following features:

- portable design, provided with tyres for simple mobility
- easy towing, towing-bar affixed.
- conical-shape shelling drum ensures high percentage (99-100 per cent) separation recovery and no broken grain.
- blower designed with air control for regulated blowing to separate clean shelled corn from fine waste.
- shaker separates shelled corn from cobs.
- labour requirement of 3, to feed shell and bag the grain.
- all steel construction.

P.I. FARM PRODUCTS
Km 16, Malanday
Valenzuela, Metro Manila
PHILIPPINES





AMAR MAIZE SHELLERS TYPE A AND TYPE B

This cylinder automatically separates the grain from the husks which are then expelled from the machine on three sides.
Technical specifications:

	Type A	*Type B*
power required (hp)	8	5
output of clean grain (quintals/h)	20-50	15-40
RPM	700	700
germination	98%	98%
height (m)	0.9	0.8

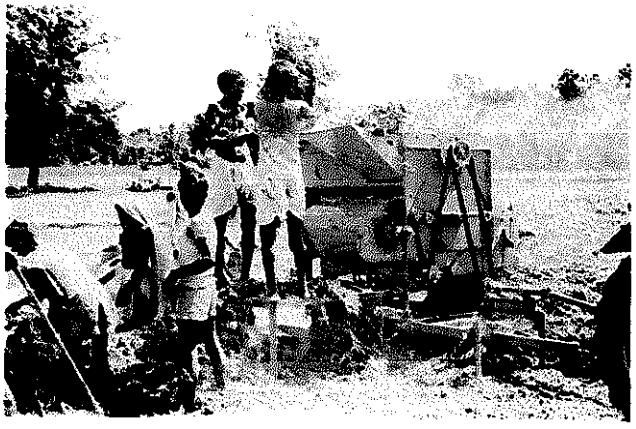
AMAR AGRICULTURAL IMPLEMENTS WORKS
Amar Street, Gill Road
Janta Nagar, Ludhiana-141003
INDIA

AB/MS/40 AND AB/MS/30 MAIZE SHELLERS

The AB/MS/40 sheller features a single shelling cylinder and a feed elevator. It has a power requirement of 10hp for electric motor or diesel/petrol engine drive. The capacity of the AB/MS/40 can reach 4 tonnes/h of shelled maize.

The AB/MS/30 (illustrated above) is a simplified model of the AB/MS/40 described above. It features the same single shelling drum unit, but has a feed chute instead of a cob elevator. The height of this feed chute is kept to a minimum by dispensing with a primary shaker shoe leaving the two sieve shoe to cope adequately with the reduced throughput. The AB/MS/30 is available as a static or mobile unit with a choice of drives by electric motor (power requirement 10hp) or diesel or petrol engine. Capacity is up to 3 tonnes/h of shelled maize.

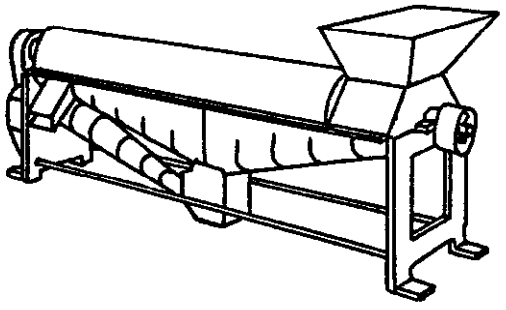
ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.



JYOTI GROUNDNUT THRESHER

The Jyoti groundnut thresher is an axial flow thresher, i.e. the plants move in a direction parallel to the beater axis. The pods are separated from the remainder of the plant in the threshing chamber so that the latter is expelled at the other end of the thresher. The pods, leaves and other impurities which remain then fall onto the sieve, where the leaves and light matter are removed by air from the blower. The clean pods then fall through the sieve and are discharged through the pod outlet. The thresher requires 10hp and is operated by 3-4 people. It can be used to thresh moist or dry groundnuts, and can also be adapted for other crops such as paddy, wheat and millet. Capacity ranges from 300-800kg/h of pods depending on the moisture content.

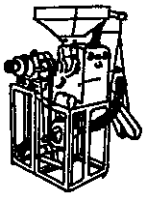
JYOTI LTD.
Bombay Shopping Centre
R.C. Dutt Road
Vadodara 390 005
INDIA



CECOCO PEANUT THRESHERS

This machine is designed to remove peanut pods from the haulm, chopping the remaining material into pieces of 10-12cm length. The power required is 1-3 or 2-4hp, depending on the model, and the capacity ranges from 250-370kg/h.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN



BEAN DEHUSKERS

LCS-300 BEAN SHELLER

LIM CHIENG SENG FACTORY
92-94 Sawanvithee Road
Nakorn Sawan
THAILAND

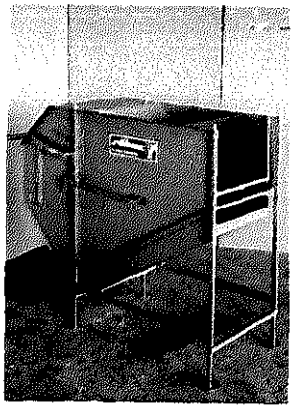
CECOCO BEAN DEHUSKER (illustrated)

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

MOON MAIZE SHELLER

This maize sheller is designed for medium capacity. It comprises a cylindrical, peg-type drum. This design enables the drum configuration to be changed to suit differing crop conditions. The Moon maize sheller incorporates a primary cleaning fan. It has a power requirement of 4-6hp and can shell 2500kg of maize per hour.

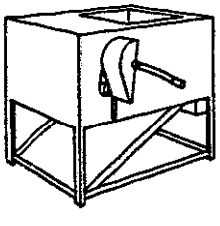
R. HUNT & CO. LTD.
Atlas Works, Earls Colne
Colchester, Essex CO6 2EP
U.K.



WINNOWERS

HAND WINNOWER (illustrated below) A hand-operated winnower for cleaning jowar and other crops. Capacity is 100-150 bags/day. All-steel body fitted with bearing and pedestal.

MAHARASHTRA AGRO IND. DEV. CORPORATION LTD.
Rajan House, 3rd Floor
Near Century Bazar, Prabhadevi
Bombay 400 025
INDIA



RÖBER HAND WINNOWER (illustrated left) This is a hand-driven winnower featuring 3 sieves, and a built-in ventilator. It has a capacity of 1.5 tonnes/h.

RÖBER GmbH
Friedrich-Wilhelm-Straße 79
4950 Minden (Westf 1), Postfach 1227
W. GERMANY

MINI WINNOWING MACHINE MEW-6 A hand-operated winnower constructed from sheet steel and angle iron.

MODERN ENGINEERING COMPANY
1A Anna Street, Velandi Palayam
Coimbator 641 025, Tamil Nadu
INDIA

WINNOWER 'JOLIE BRISE' Featuring 6 screens this winnower is designed for cleaning wheat, barley, rape seed, oats etc. It has a capacity of 1.5 tonnes/h and can be equipped either for hand or motor drive. The power requirement is 0.5hp. Overall weight is 130kg. Optional equipment available includes an elevator with sacking attachment, and extra upper screen, and an extra lower screen.

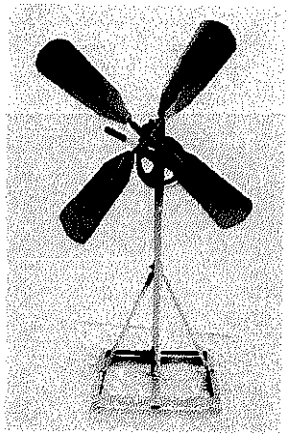
ASE EUROPE N.V.
Century Centre
de Keyserlei, 58 Box 1
B-2018 Antwerp
BELGIUM

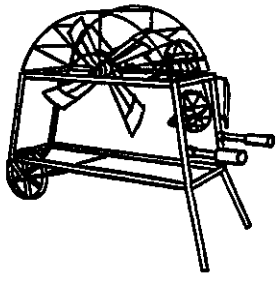
CECOCO HAND WINNOWERS Cecoco produce two hand-operated winnowers. The first, the A1-model has a capacity of approximately 650kg/h, and an overall weight of 30kg.

The 'Hand grain winnower' is a smaller model weighing 17kg. Capacity is 650kg/h. A single-phase motor drive is available.

The hand grain winnower features three outlets (a) for whole grain or kernels, (b) for broken pieces, and immature grain and (c) for chaff, hulls and dust.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN





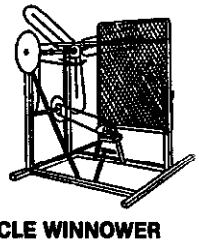
WINNOWING FANS

HAND WINNOWER This simple hand winnowing fan (illustrated above left) has a capacity of 500-800kg/h. Blade diameter is 120cm and overall weight is 25kg.

COSSUL & CO. PVT. LTD,
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

WHEELBARROW-TYPE WINNOWING FAN Fixed to a stand with a single iron wheel at the front and two handles at the rear for easy mobility, this hand operated fan (illustrated above right) is driven by a series of bicycle chains and cogs. The stand is constructed from angle iron, and the blades have a diameter of 37cm. Sathiyawadi also produce a winnowing fan to be fitted to a hand tractor.

SATHIYAWADI STORES AND MOTOR TRANSPORTERS LTD.
P.O. Box 42, Kuronegala
SRI LANKA



CYCLE WINNOWER

This winnowing fan is fitted with a bicycle seat and pedal drive mechanism. The frame is all steel, and the blades have a span of 120cm. Capacity ranges from 1500-2000kg/h.

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

8. POST-HARVEST CROP PROCESSING

OXFAM

Milling grain in a traditional quern.

Most crops need to be dried, packaged or processed into some slightly different form from that in the field. The type of crops to be considered in this section will be largely seed crops for human food, animal feed and oil extraction, with less emphasis on fruit, vegetables and fibre crops; attention will be focused on the small- to medium-scale items of equipment suitable for household or village use.

This section looks at the processes needed to increase the nutritional or market value of harvested and threshed crops. Inevitably there is the need to ensure the material is dry enough, if it is to be stored for any length of time, so the section starts with a brief look at drying and storage methods. This is a complex subject in its own right and the lack of space devoted to it in no way reflects its relative importance. Users concerned with this aspect of post-harvest processing should consult local expert advisers before investing in equipment.

This section also includes equipment designed to clean (especially) grain before and sometimes after, a milling or shelling process. These items of equipment precede grain milling and other processing equipment, which is considered in order of horsepower requirement within each category of equipment, starting with manual machinery. With this type, low efficiency is clearly undesirable even though a technique is effective; this is particularly true for oil processing equipment. There are, however, many occasions where the only feasible solution is a piece of equipment which is hand- or pedal-powered, and the low efficiency, in terms of human effort used, is accepted. Improved efficiencies can be achieved with animal-powered equipment, especially presses and crushers (e.g. sugar-cane crushers). Here, the efficient conversion of the animal draught power to rotary motion is the most important consideration.

In the majority of cases, though, crop processing

equipment will be powered by motors and these are always a vital factor in the selection of equipment, and may cost far more than the actual process machine. This is particularly so where electricity is not available and small petrol or diesel engines are required.

TECHNICAL CHARACTERISTICS

Grain-drying machinery

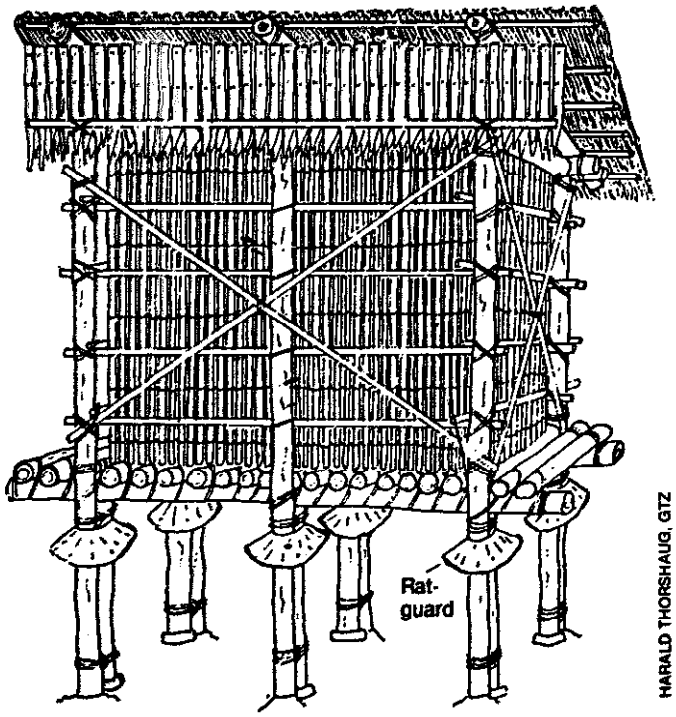
Although grain can be dried on a continuous or batch basis, it is much more convenient at low and medium scale to use the batch system. In the commoner designs the seed or grain is contained in a large rectangular box or tray. The grain should be spread evenly over the perforated plate in the bottom of the box and heated air will be blown up through a lower plenum chamber.

Typical drying rates would be 1 per cent per hour of moisture removed. The power requirement for this type of operation would be 1.5kW for 1t capacity. The fan may be diesel or electrically operated and the heat may be provided by kerosene, electricity, rice hulls, gas or other fuel. Grain can be loaded in sacks but it is usually loaded in bulk, and discharge spouts are provided with sack mounting hooks.

Storage

The imperatives of storage equipment are that it must keep the grain dry and free from insect and rodent attack. In some types of store, where the grain may not be quite dry enough for long-term storage, ventilation is considered important. In these stores, and most others, it is common to dust the grain with malathion or similar insecticide to protect it from insect attack. Grain which is sufficiently dry can be stored in air tight containers which may be fumigated with a gas, often derived from aluminium phosphide tablets.

Rodent attack is usually minimized through the use of rodent-proof materials, the use of rat guards on the legs of wooden stores, and through general rodent control measures.



HARALD THORSHAUG, GTZ

Improved Maize Crib.

Air-screen seed cleaners

These machines will clean seed efficiently, removing leaf, chaff, soil and other rubbish. Small-scale versions are hand operated and are suitable for sorghum, millet, maize, soya beans and any free-flowing seed crop. Different screen sizes can be provided to suit any size of crop and usually a minimum of two screens is needed for each operation. The upper screen filters out oversize material and the lower screen filters out the undersize. The middle-sized material is blown through a winnowing section to remove the light bits of leaf, chaff, glumes and hollow seed. This machine can be used immediately after a thresher and prior to hulling, milling or resowing.

Simple winnowers are also available with an electric motor-operated fan. These will separate the light material from the heavy, simply by blowing the mass of material up into an air column. In one type, the heavy material continues upwards while the light particles are blown sideways. Another type allows the heavy material to sink to the bottom of the column. This machine is suitable both for pre-cleaning a seed crop or for separating hulled rice, coffee etc. from the husks. The winnowers in this section are those usually used in crop processing environments, whereas field scale winnowers are included in Section 7.

Grain milling

The milling of grain and grain legumes for human and animal feed is one of the most basic of crop-processing requirements. The following paragraphs discuss the main technical characteristics of the commonest types of mill.

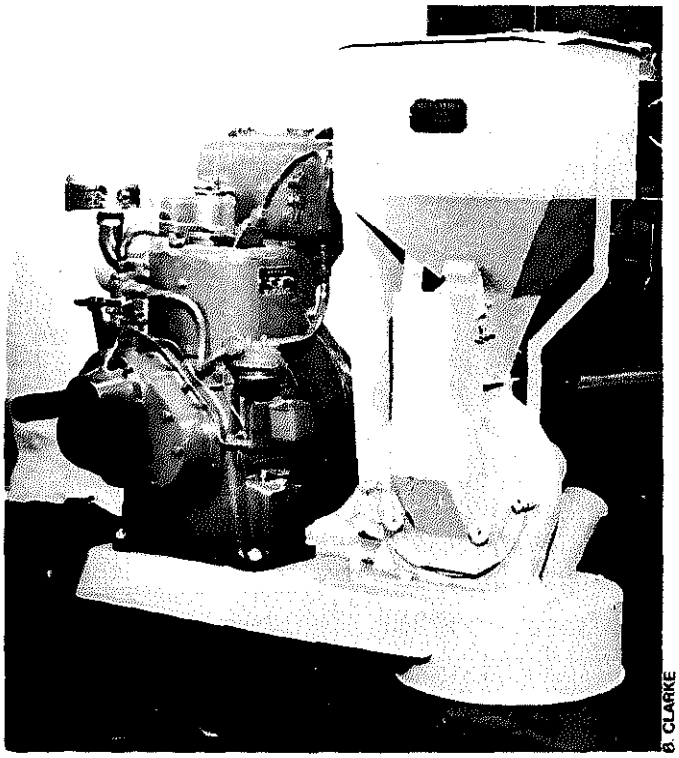
Plate Mill The plate mill is usually limited to about 7kW and is derived from the stone mill or quern. In the modern plate mill, two chilled iron plates are mounted on a horizontal axis so that one of the plates rotates and the grain is ground between them. The pressure between them governs the fineness of the product and is adjusted by a hand screw. The grain is usually coarsely cracked in the feed screw to the centre of the plates. Grooves in the plates decrease in depth outwards towards the periphery so that the grain is ground progressively finer until it emerges at the outer edge and falls by gravity into a sack or bowl.

This machine is also very effective in grinding wet products such as wetted maize, tomatoes, peppers and spices. Water may be added by simply pouring it into the feed section as required. Manual versions of the plate mill are available but the work is hard and throughput is only between 1 and 2kg/h on cereals. It is more effective than pounding or rubbing stones, however, and will produce a fine meal.

Roller Mill For feeding ruminants, grain needs only to be crushed rather than ground. A roller mill which simply flattens the grain is perfectly adequate for this purpose, a 3kW machine being able to crush up to ½t/h of barley.

Hammer Mills These range in size from 2 to 20kW in village operation and consist essentially of a circular chamber in which beaters whirl at high speed. Around the tips of the beaters a circular perforated plate allows the shattered grain to filter through either to fall out of the base by gravity or to be sucked through a fan to an elevated delivery point. The size of the holes in the perforated plate determines the particle size and a 1mm hole size is suitable for most human foods, whereas a 3mm hole is preferred for animal feed.

Most grain crops can be ground in a hammer mill. The input to the mill can be controlled by hand in a feed tray to the centre or side of the mill. Alternatively, bulk hoppers can be mounted over the mill to give a continuous operation. The mill may be driven by a direct-mounted electric motor, by V-belt or flat belt. The simplest type is the direct-mounted, gravity-discharge mill because there are no additional belts or bearings except those of the electric motor. In this case the motor is flange-mounted on the back of the mill and the hammers are keyed directly on to the stub shaft of the motor. The flat belt type is next to be preferred, and finally the V-belt drive type, which suffers from the problem of replacing the V-belts. The direct drive mill needs no guards and is clearly safer. It is also up to 20 per cent more efficient.



B. CLARKE

Small grain hammer mill with diesel drive.

The hammer mill is used just as frequently for animal and poultry meal production as for human food. Oystershell, an ingredient of poultry meal, can also be ground in the hammer mill, but wear rates are much higher.

The vertical meal mixer is excellent for blending meal with concentrates or other ingredients. A vertical conical-bottomed hopper has a central screw auger which re-circulates the meal. A 2t hopper would probably have a 3kW mixer drive motor. Several companies supply a complete mill, mix and storage unit containing a feed hopper, and a hammer mill with pneumatic delivery to a vertical mixer set in a round or square hopper. This is usually a good way to buy a matched system for a reasonable price.

Rice Hullers

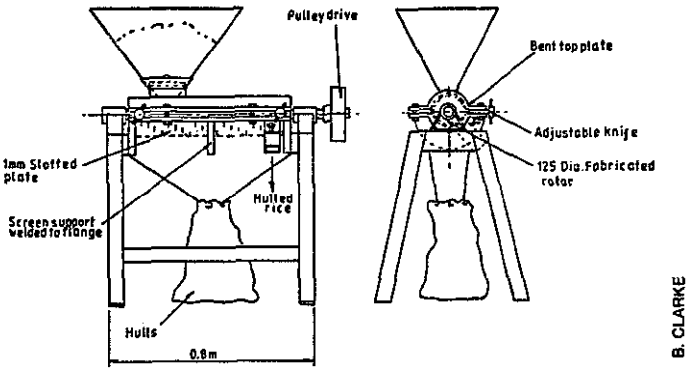
For village use, the Engleberg huller is often quite satisfactory. They are commonly available in small hand-operated sizes or motorized versions of 3-10kW. Throughput, of course, varies with many factors but roughly from 10kg/h for hand operation up to 300kg/h for the bigger models.

The machine comprises essentially a cast steel rotor with rasp bars on it which turns inside a cast housing with a slotted plate in the base. An adjustable knife projects into the side of the housing to increase the stress on the grains of rice. The mill is mounted horizontally on a steel frame so that paddy rice fed in at one end circulates along the rotor to emerge hulled at the other end. Pieces of hull and bran come out through the slotted plate but a separation is still necessary after discharge. A motor-driven aspirator or hand winnower can be used for this task. A significant number of grains are broken by this process but the food value is unimpaired. If an unacceptable amount of bran remains on the grain, it can be passed through a second time at the risk of even more brokens.

Less rice is broken if it is parboiled. This practice is performed on about 50 per cent of all rice grown and is simply a soaking and heating process which pre-cooks the grains, loosens the hull, sterilizes and preserves the rice. Village parboiling can be carried out with crude boiling pans but enclosed fires, chimneys and insulation can increase their efficiency significantly.

More sophisticated rice hullers are available, but generally a higher level of maintenance is required. The most popular is the rubber roller-huller which shears the paddy between a pair of rubber rollers of about 150mm diameter, turning in opposite directions at different speeds and with a gap of about 1.5mm. Another alternative is the under-runner disc huller which consists of two flat stones, one of which rotates. The grain is fed through a hole in the centre of the upper stone. It is then sheared in the gap between the horizontal stones as it moves outwards towards the periphery.

Special polishers are available for removing the bran after hulling. One type spins the rice by means of rotor blades to which are attached leather strips. These rotate at high speed abrading the rice grains within a slotted plate drum. Another type uses carborundum stones against the slotted plate. For the village scale of operation, an Engleberg huller with an integral leather-strip polisher is an attractive system.



B. CLARKE

Fabricated rice huller.

Groundnut shellers

Simple hand- or motor-operated machines can decorticate groundnuts. A rasp bar reciprocates in a semi-circular drum which has a coarse screen in the base. The clearance between the bar and the screen is too small for the nut with the shell. The holes in the screen are large enough to let the broken pieces of shell

and whole kernels fall through. The machine can be trickle-fed automatically or simply fed by handfuls.

Coffee pulpers

Both hand- and motor-operated pulpers are manufactured. These strip the flesh off the 'cherries'. The manual type usually comprises a vertical disc covered with rounded projections. It is turned by a handle to rasp the cherries against an adjustable blade. Manual capacities are up to 300kg/h. The motorized versions have a roughened drum, possibly of stainless steel, which rotates to rasp the cherries against a cast iron breast. For both types of pulper, a plentiful supply of water is required to wash away the flesh, leaving the beans to be separated for further processing. A 1kW machine can handle up to 750kg/h of coffee cherries. It is important to use the correct discs and drums for the particular type of coffee.

Coffee hullers

Once the coffee has been dried, it has to be hulled in either a hand- or motor-driven huller. These machines break open the hulls which encase the beans, using a shearing action. Most of them are of the Engleberg type — that is to say, a ribbed, horizontal, cast iron rotor which turns inside a close fitting housing made of cast iron on top and either solid or woven wire on the underside. The coffee is fed in at one end and the shearing stress may be adjusted by a side-fitting blade. The beans, hulls and dust emerge from the discharge and must be separated by sieves and winnowers. The coffee must be crisp and dry to be satisfactorily treated in this machine.

Oil extractors

The most efficient small-scale press for seeds consists of a machined, tapered screw-auger which rotates in a perforated drum or slotted housing. The slight taper allows adjustment of the flight clearance by screwing it in or out of the housing. The pitch of the screws often decreases towards discharge in order to increase the pressure gradually. The oil emerges from the slots or holes along the housing, and the residue at the discharge annulus at the end of the screw. Careful adjustment of the slot width, temperature generated in the extraction section and insertion of the screw are important factors in efficient operation of this machine. Generally, most small oil seeds such as sunflower, sesame, safflower and cotton seeds can be processed in this machine quite effectively.

Palm oil presses can be very much simpler. A perforated drum or cage is required and the fruitlets are crushed simply by means of a close-fitting ram into the drum. The ram may be hydraulically or screw operated. It can be a manual system developed perhaps from a lorry jack, or motorized.

The oil contained in the inner nut of the palm oil fruitlet is of a different type, and needs separate processing. Centrifugal crackers are usually used to break the shell from around the kernel. In this machine, bars rotate at high speed to throw the nuts against a surrounding chamber wall, thus breaking them open. After this, the two components of shell and kernel are separated by one or more of a variety of means such as screens, winnowers and clay baths. The screw press can then be used to extract oil from the kernel, or, alternatively, simply pounding and boiling will extract most of the oil if a manual method is preferred.

Coconut shredder

At domestic and village level the coconut is first of all hand husked on a firm spike, and is then chopped open with a large knife to expose the meat. The open nut is then dried in the sun to release the copra. The shell can also be burnt to provide heat for kilns in which the copra is dried. The white meat is pared by hand and shredded in a machine. Shredding machines are available in various forms. They consist usually of knives mounted on discs which rotate at high speed. A plunger may force the coconut on to a horizontal disc, or sets of rotating vertical discs may inter-leave with a stationary set of discs to tear the meat apart. Adjustments to the blade settings permit the production of chips, slices, strips, threads and various other types of product.

Oil press for coconut

The meat is first passed through a hammer mill with a 6mm screen. It then passes to a plate mill set at the minimum clearance, to produce a finely ground yet soft pulp. This is mixed with hot water and pressed. Various types of pulp press exist including the perforated drum mentioned under 'oil extractors', but smaller filter presses which pump the slurry through a fine cloth mesh are also available and are cheaper. Separation of the oil from the milk which comes from this process is best carried out in a centrifuge.

Cassava

Medium-scale equipment is available for processing cassava into a pre-cooked meal known as *gari* in many areas of West Africa. The crop is hand-peeled although many attempts have been made to develop a machine peeler, and is then washed. A grating drum which consists of a roughened perforated plate nailed to a wooden cylinder is driven at about 1000 rev/min beneath a wooden hopper containing the peeled tubers. The tiny chips of cassava are ripped off and collected at the back of the grater ready for bagging and fermenting for about 1-5 days on wooden racks. They are then pressed, about six bags at a time, in a wooden frame with a large capstan-type screw on top. Some of these have a screw at each corner of the square frame, others just have one central screw. Water pours out of the porous sacks.

The blocks of pulp are often disintegrated again in the grater and then fed onto the cooking pan. This may be either a series of hemispherical pans, a long flat pan or semi-circular trough. In the latter case a rotor turns with angled paddles along the length of the trough, keeping the granulated cassava moving down the trough. Heat is provided underneath the trough by firewood, gas, coal or fuel oil. The temperature must be sufficient to gelatinize the raw cassava and stabilise it. Moisture is also driven off and the product emerges hot and dry. After cooling and sifting, it is ready for packaging in sacks or heat-sealed polythene bags. It is often hammer-milled one further time and mixed with other cereals such as ground rice to make other food products.

Sugar-cane crushers

The main features of these machines are sets of rollers through which the canes are crushed. They can be

powered by hand, animal, or motor and are available with either two or three grooved rollers. Most machines have horizontal rollers and are geared down to increase the torque. The cane is fed manually through the rollers and a small 3kW machine could crush from ½-1t/h. The grooves need to be re-machined at regular intervals to maintain efficiency. The waste material from sugar-cane crushing, bagasse, is sometimes fed to animals, but is often used to fuel the sugar refining process.

Fodder cutters

Whilst livestock can often browse over waste material such as bagasse, a more efficient way of presenting long fodder is in a chopped form. Some cutters are curved knives hinged on a cutting plate. These are particularly dangerous if used without safety devices. Rotary chaff and hay cutters, if properly guarded, are useful for fodder crops. These are either hand- or motor-driven machines for cutting long straw and hay down to a more palatable size for cattle and other ruminants. The crop is also more suitable for storing, mixing and bulk feeding. The usual design incorporates a tray which feeds the bundles into a series of knives which are set as rotors in a wheel. The feed rate determines the chop length and is usually adjustable from about 10-60mm. These machines will cut most types of green or dry fodder.

Advantages

Advantages of using powered processing machines are:

- Considerable time is saved on the performance of onerous and laborious manual tasks.
- Production rates are increased, which may lead to an increased cash profit or an increased food supply.
- Crops which might otherwise perish can be dried or processed to a state of longer preservation, again leading to greater food availability or cash profit.
- A centralized service machine, or a privately owned machine, may open up the way to growing new crops previously considered impossible, or unprofitable.

Alternatives

For a crop which is already being produced in a particular area, one alternative to purchasing a (motorized) machine is to use the traditional method. The traditional method invariably involves a machine constructed from local materials of wood, stone and twine which is either manually or animal-powered. Another alternative is to use locally-made improved devices, using similar materials and designed and produced in response to locally-felt needs and demand in rural workshops.

Traditional methods are available for most crops. Major exceptions are when new crops are introduced, and these are often a cash crop such as oil, gum or beverage.

Solar drying

Many crops are sun-dried for preservation. In most tropical countries this is still the best way to dry many crops even at factory scale. Rice, for example, may be solar-dried after parboiling. Several perishable fruits and vegetables such as raisins, prunes, yams, are preserved by solar drying. The seeds of any crop need to be dried to below about 15 per cent to ensure good storage.

Simple aids to solar drying have been developed by using black polythene covers and chimney structures. These can be of considerable help in increasing the drying rate and protecting the crop from contamination and rain.

Grain storage

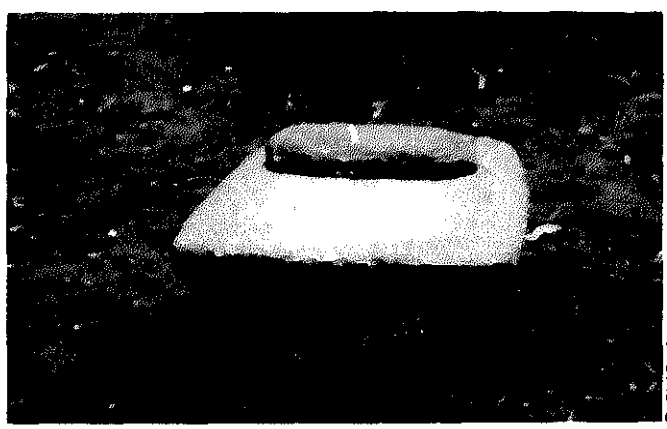
Some of the most common indoor and outdoor structures used for storage on farms are made of mud and split bamboo; in them the grain is usually damaged by insects, fungi and rodents. The structures cannot be effectively fumigated. Some of the indoor bins that are being built are metal bins, structures of burnt bricks plastered with cement, welded wire-mesh bins, and paddy straw and mud structures. The outdoor bins are constructed of metal and brick and appear as flat- and hopper-bottom metal bins, composite bins and reinforced brick bins. They can be hermetically sealed and placed underground or partly above ground. The capacity is about 500kg.

The bins used in villages are either circular or square, with capacities ranging from 500 to 1000kg, made of standard sizes of galvanized iron sheets. The height may be from 0.5 to 1.0m. The circular bins are easy and economical to fabricate, while the square ones are convenient to keep in the corner of a building. The average life of metal bins is said to be over 20 years.

Bins can also be made of ferrocement, high-density polythene and wood. Ferrocement bins are made of cement mortar and closely spaced wire mesh in capacities ranging from 0.6 to 3.0t. They are cylindrical and have flat bottoms and domed roofs. Wall thickness is normally 25mm.

Grain milling

The traditional method of grinding is by rubbing between flat stones, or in 'querns', or pounding with a mortar and pestle. The last method, especially, is still widely practised as a means of threshing or dehulling and, as a less common application, for grinding. Grinding rates are very limited, usually to less than 0.5kg per hour. Querns and rubbing stones are more effective than pounding, but grinding rates are still less than 1kg/h.



B. CLARKE

Rubbing stones for milling wet grain.

The rubbing stones rely on a local supply of suitable stones. Volcanic basalt is an excellent material for this purpose, together with granite or sandstone. One rectangular stone 40cm-60cm long by 30cm-50cm wide is simply rubbed by a small stone of about 10 × 20cm and 10cm deep in a back-and-forth scrubbing action. Water may be added to prevent blocking and to soften the material.

The quern, as used 2000 years ago in the Roman

Empire, consists of two flat stones of about 35cm diameter with a hole in the centre of the upper stone through which grain is poured. A wooden handle is usually fixed to the upper stone so that it can be rotated. The grain is crushed and sheared between the two stones before emerging at the outer edge. Larger versions of this model can be made for animal power, multiple man power, water-wheels or windmills. Stones over 100cm diameter are common in this case. A certain amount of skill is needed to dress the stones to fit together and to cut channels in each matching face, in order to grind the grain efficiently.

OXFAM

Pounding grain.

The mortar and pestle is very commonly used in many countries. This usually comprises a hollowed-out section of tree trunk which makes a bowl and large pole up to 2m long and weighing about 10kg. The end of the pole or pestle is rammed repeatedly into the grain in the bowl until the process is complete. For hulling rice the grains are often placed in a loosely filled cotton bag during the pounding process; the hulls are then winnowed away later.

Oil extractors

Few traditional techniques exist for this purpose when applied to seeds and where they do they often require considerable skill and force — and even then only meet with limited success. There are exceptions for palm oil for which village techniques do exist for sterilizing and squeezing out the oil from the fruitlets. Boiling pans, large pounding sticks and lever presses are all that is required. In some parts of West Africa the squeezing process is achieved partly by trampling fruits with bare feet in specially constructed pits.

Cassava

Domestic processing is common and to be recommended for home consumption, or small-market and roadside sales; large volume production techniques should only be considered when it is sold as an estate or co-operative cash crop. At any size of operation, however, the tubers need to be hand-peeled and washed, and a simple hand-grater or mortar and pestle will then prepare the crop for fermentation in bags or jars. Finally, after two or three days, the water is expelled by heavy stones or lever presses, dried and pre-cooked.

Choosing equipment: costs and benefits

The cost of processing most crops is expressed as a cost per tonne of incoming crop. As most crops are seasonal it is convenient to base the costs over a one-year period.

The capital cost of the equipment may involve installation costs onto a concrete slab in a covered building. The building may or may not have walls and may need to be lockable. The cost of installing the power supply is not shown here but may need consideration. Other costs include depreciation, maintenance and repairs, fuel, loss of interest on capital and labour costs. Rates or ground rent may have to be paid on urban sites.

In the following table, indicative figures are given for the capital costs and running and maintenance costs of a variety of crop-processing machines commonly in use in developing countries. Also indicated are the requirements with respect to power source.

Indicative costs

Process Equipment	*Capital*	*Running and maintenance p.a. (6h/day excl. fuel costs)*	*Infrastructure*
Hammer mill Elec. 2kW	500	50	Elec. power
Elec. 5kW	750	75	Elec. power
Diesel 10kW	2000	200	Fuel supply
	3000	300	Fuel supply
Plate mill Elec. 0.5kW		15	Elec. power
Elec. 5kW	750	75	Elec. power
Diesel 10kW	1500	200	Fuel supply
Sugarcane mill 5kW	600	50	Elec. power
Huller			
Rice Diesel 10kW	1500	100	Fuel supply
Electric 10kW	800	100	Elec. power
Sorghum, Electric 5kW	1000	150	Elec. power
Millet, Electric 5kW	1000	150	Elec. power
Oil extractor, Elec. 5kW	4000	200	Elec. power
Diesel 5kW	4500	200	Fuel supply
Cassava garifier. Electric and gas or heating fuel 50kW	30,000	500	Elec. power and fuel supply
Animal feeds			
Hammer mill 10kW Electric	1000	75	Fuel supply
Roller mill 5kW Electric	750	75	Power supply
Chaff cutter 3kW Electric	750	60	Power supply

Economics

In order to establish whether investment in a crop-processing machine will be profitable, factors other than costs need to be taken into consideration. These can include expected capacity utilization over the year (in the case of custom services this is highly dependent on the number of customers and competitors); flexibility of machinery; supporting infrastructure (electricity, transportation, markets); and availability of fuel supplies and spare parts (both now and in the future).

The process of calculating overall costs of a grain hammer mill and a hand-operated plate mill is illustrated below. Once the cost is calculated, it can then be used to estimate whether a satisfactory profit margin can be achieved given local patterns of demand for services.

In the case of a hammer mill the annual throughput must be estimated by gauging the daily throughput and the number of working days per year. A service or contract mill is likely to be running in excess of 300 days per year and the fuel costs, if it is diesel-driven, will obviously be considerable, outstripping perhaps in one year the capital cost of the mill. The profits from this type of operation, however, should cover this. The feasibility of running these machines is clearly linked to the number of people likely to make use of them and the number of hours for which they can be operated.

The performance of machinery cannot always be maintained. Production will be interrupted by the normal turnover of customers, and the efficiency of most machines declines gradually as wear takes place in cutting faces and screens, etc.

Payment for service milling and hulling may also be made as a proportion, say 10 per cent, of the crop being processed. If this is the case, the cash equivalent has to be calculated. One must bear in mind the implications of storing considerable quantities of crop, together with the extra bagging, marketing and labour costs.

Example: Grain hammer mill Annual running costs of a grain hammer mill for the first five years of life:

Cost of capital: mill 2000, financed by loan 15 per cent per year paid over 5 years	300
Cost of building + concrete plinth: 100 paid in cash. Loss of interest @ 8 per cent	80
Depreciation: mill over 5 years, zero resale value	400
Maintenance and repairs: mill; new drive belts; bearings; beaters; perforated plates	200
Engine	150
Diesel fuel running 300 days @ 5 hrs per day	3000
Labour	2000
Total production cost	6130
Average throughput of maize per year for human feed, flour size below 1mm	75t
Annual cost per tonne of maize $= \frac{6130}{75} =$	81.73

Example: Hand-operated plate mill Annual running costs of a hand-operated plate mill for the first five years of life:

Cost of capital: mill 100, financed by loan 15 per cent per year paid over 5 years	15
Depreciation: mill over 5 years, zero resale value (in fact these mills often last much longer than 5 years)	20
Maintenance and repairs, new plates	20
Labour (assumed to be private)	—
Total annual cost	55
Average throughput of maize per year assuming 2hrs per day use at 1kg/h and 300 days per year	600kg
Annual cost per kg of maize $= \frac{55}{600} =$	0.09
Annual cost per tonne of maize, 0.09 × 1000 =	90.0

Scale of Equipment

Perhaps the most important decision to be made when investing in crop-processing equipment is that relating to the size and type of machine to be purchased. The purchaser must decide here whether the machine is to be totally for their own use, totally for custom work or for a combination of the two. Machinery is more profitable if it is run for as long a period each year as possible, a farmer who buys a larger machine than is needed, in the hope of earning income through custom work, may find it to be a loss-maker if the expected customers fail to materialize.

Before deciding on the appropriate scale of machinery, therefore, an investigation should be made of the local conditions prevailing in the crop-processing sector. How are crops processed at the moment? Is there a need for custom services and purchasing power to back up this need? Would customers expect to pay on a percentage crop basis and would this cause problems of storage and marketing? Would the machine produce an end-product which suits the taste of local customers compared with that of products prepared in the traditional manner? If not, very few families may be willing to use the custom mill. Will the machine process more than one crop so that demand can be maintained in the event of changing cropping patterns or fluctuations in supply of a single crop?

A final factor affecting the size of equipment will be the size of available prime movers. For example, if a 10kW diesel engine is the best available or already owned prime mover, then it may be wise to buy a 10kW machine to match it.

Health and Safety

Much crop processing equipment contains cutters, knives, rasps and so on. These are potentially dangerous if they are not properly guarded.

Motors and engines are items of inherently high speed. The machines they drive are often directly coupled to rotate at the same speed and the safety regulations developed in some countries are often totally disregarded in others.

The two major hazards are; first, unguarded belts and machinery and, secondly, poorly maintained electrical wire and connections. Careful instruction is needed in the initial stages of operation. Petrol and diesel engines need adequate exhaust pipes leading outside the building to prevent the build up of fumes.

The most important features of safety when dealing with high speed rotational machinery (as most of the foregoing equipment is) are careful retention of guards on all belts, pulleys and transmission systems and secondly, the protection of all feed sections against probing fingers. A wise precaution is often to provide a wooden pusher to feed all mills, mixers, hullers, pulpers, etc. or at least provide a coarse guard screen for the free

flowing crops. Customers or casual visitors should be kept to safe areas. This particularly includes children.

Social Impact

Traditionally, crop-processing activities are carried out primarily by women. The techniques they use are extremely arduous and they involve a large investment of time for very little result. Two categories of women engage in this type of activity: farm women, who process their own crops for family consumption; and landless women, or the wives of marginal farmers, who process other people's crops as a way of supplementing family income.

The introduction of crop-processing equipment has different implications for these different sectors of society. Farm women may find they are released from tiring, unproductive work so that they can devote more time to child-care, or if it is available, involve themselves in more remunerative kinds of activity (which would help them pay for the use of machinery). Sometimes, however, the time saved is merely diverted into travelling to the mill and standing in queues for hours on arrival.

Landless women may find themselves relieved of their only means of earning a living. Indeed, the introduction and spread of Engleberg mills in countries such as Indonesia and Bangladesh has destroyed millions of part-time jobs for the poorest sections of society. Estimates show that some 7 to 8 million women lost their jobs following the mechanization of rice milling in Java. Much the same is happening in Bangladesh where each new rice mill puts about 350 women out of part-time employment. Given the greater mechanical efficiency of such equipment compared with traditional techniques, it would be difficult to prevent such changes. It would seem to be very important, however, to plan for the creation of alternative, equally remunerative jobs for these people displaced because of them.

The tools and equipment used to process crops in the traditional way are mainly fabricated locally, by farm families themselves or by rural artisans. Commercial machinery on the other hand, is normally manufactured in urban factories or even overseas. The introduction of such machinery means a decline in demand for the products of rural artisans and a flow of cash away from the rural economy. It will also probably involve an increased drain on the country's scarce supplies of foreign exchange for imported machines, spare parts and fuels. In many cases, the largest part of most suitable machines could be made locally by the use of simple machine tools and welding equipment. Measures to encourage this — such as the training of rural artisans, the upgrading of technology in rural workshops, and provision of credit and other support services — should be encouraged.

Maintenance

The maintenance schedule for all rotational machinery includes the care of belts, bearings and transmission components. Oiling and greasing of the bearings according to the manufacturers' instructions is essential. V-belts should always be replaced in matched sets, never singly, otherwise all the load is carried by the shortest belt and they all break in turn.

Machines with perforated plates should be checked for wear and breakage, the latter occurring most frequently when unscreened samples are fed into the machine. Metal trash and stones can cause intolerable damage. Knives and beaters should be checked frequently for wear and either sharpened, reversed or replaced according to the manufacturers' advice. High speed beaters for hammer mills should at least be checked for balance statically, on scales, so as to minimize vibration in operation. Worn beaters are often built up and repaired by welding and grinding square.

All screens should be checked for wear and blockage; the latter may be corrected by scrubbing with a wooden block or wire brush. Drying in the sun will also loosen many of the stubborn particles or seeds in a screen.

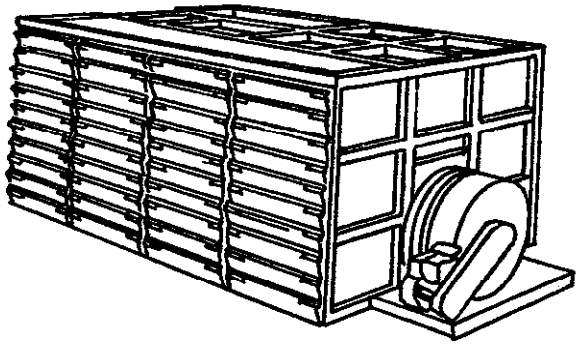
Training

The most difficult aspect in operating much of the motorized process machinery is the maintenance of the diesel engine drive unit. The understanding of the manufacturers' instructions is the only other requirement. Some hullers, for example, require a pre-graded sample before they will operate consistently. No formal course of training is required, but the importance of adhering to the recommended maintenance schedules, correct machine settings and cleanliness can all be learnt in a matter of half a day of practice and supervision.

Although the operation of the machinery is simple enough, further training may be required if the operator has also to maintain the equipment. The hammer mill, for example, needs regular checking for wear on the hammers, and the plate mill similarly needs to be checked for wear on the plates. Tools may be required, but nevertheless most of these maintenance jobs are fairly simple to learn.

One of the hardest jobs relates to *gari* production. This is a pre-cooked meal made from grated cassava. The quality of the *gari* depends on the skill of the garifier operator, who operates in much the same way as a cook. In the continuous systems which are growing in popularity, the temperature, residence times, additives, etc. all contribute to the quality of the product, and operators should be trained to maintain quality standards.

Dr Brian Clarke
Silsoe College



VERTICAL BIN BATCH DRIERS

The illustration shows the drier developed by the International Rice Research Institute in co-operation with NGA and MIRDC. The bin is built of wood and has four compartments and a capacity of two tonnes. It occupies 6sq.m. of floor area. A blower-burner assembly built from locally available materials produces hot air to dry the paddy.

Technical specifications:

power	3hp electric motor
or	5hp petrol engine
weight (with engine)	364kg
length	173cm
width	158cm
height	158cm
capacity	2 tonnes paddy/load
construction	wood and steel
fuel consumption:	
engine	1.5 litres petrol/h
burner	2.7 litres kerosene/h
drying rate	2% moisture reduction/h
blower speed	2000rpm
grain bed thickness	46cm
fan	56cm dia. tube-axial
drying air temperature	43°C
airflow	1.7cu.m/sec.

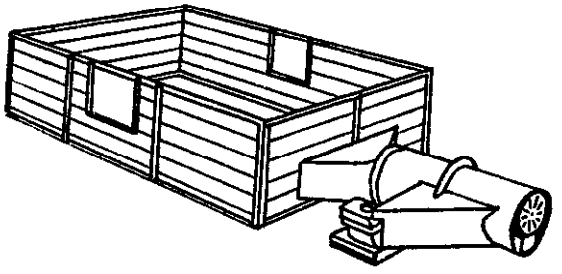
POYING'S WELDING SHOP
262 National Hi-Way
Brgy. Anos, Los Baños, Laguna
PHILIPPINES

JCCE INDUSTRIES
242 Mayondon
Los Baños, Laguna
PHILIPPINES

ALPHA MACHINERY & ENGINEERING CORP.
P.O. Box 579 MCC
Makati, Metro Manila, D708
PHILIPPINES

PALAY DRIER Two models are available each with a capacity of 2 tonnes paddy per load and a drying rate of 2 per cent moisture reduction per hour. The model KK-44B uses kerosene as a fuel and has a motor power requirement of 3 to 5hp. The model KK 44H uses palay hull and requires a 7hp petrol engine or a 5hp electric motor.

P.I. FARM PRODUCTS
Malanday, Valenzuela
Metro Manila
PHILIPPINES



BATCH DRIERS

IRRI BATCH DRIER These driers are constructed of wood or steel and can dry 1 tonne of paddy in 4 to 6 hours (illustrated above).

Technical specifications:
power; 3 hp petrol engine or 2hp electric motor
weight: fan and kerosene burner 40kg; drying bin 220kg (steel), 200kg (wood)
length, width, height (cm): fan and burner 90, 110, 60; steel bin 277, 190, 92; wooden bin 254, 254, 109
grain depth; 33-46cm
fan; 47cm diameter, vane axial type
airflow; 0.85cu m/sec.
air temperature; 43°C
fuel consumption; 0.75 litres petrol/h, 2.0 litres kerosene/h
A rice hull furnace may be used as an alternative to the kerosene burner

KAUNLARAN INDUSTRIES
Calamba, Laguna
PHILIPPINES

JCCE INDUSTRIES
242 Mayondon
Los Baños, Laguna
PHILIPPINES

POYING'S WELDING SHOP
262 National Hi-Way
Brgy. Anos, Los Baños, Laguna
PHILIPPINES

PLAIN BATCH TYPE DRIERS Steel driers for paddy, wheat, beans, coffee, nuts etc. Five models are available with one or two air blowers. Power requirements vary from ¼ to 3hp and capacities vary from 630-1700kg per charge with drying efficiencies of up to 1 per cent moisture reduction per hour.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

BATCH DRIER Powered by a 7.5hp electric motor. 1 to 1.12 tonnes can be dried in an hour with a moisture content reduction of 6 per cent (from 18 per cent to 12 per cent). The drying bin is tilted for easy unloading.

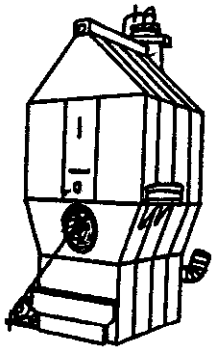
THERMAX (INDIA) PVT. LTD.
Thermax House
4 Bombay Pune Rd, Shivajinagar
Pune 411005
INDIA

GRAIN DRYER Model KB-6D requires a 2 hp electric motor or a 3-4hp engine. The capacity is 1300kg and drying rate is up to 1.2 per cent/h. A larger model with slower drying rate is also available.

YAMAMOTO MFG. CO. LTD.
813-17 Tendo-ko
Tendo-shi, Yamagata ken 994
JAPAN

CROP DRIER A large fan for drying seeds, nuts, vegetables, fish, wood, hay etc. Four models are available.

R.A. LISTER FARM EQUIPMENT LTD.
15 Gosditch St., Cirencester
Gloucestershire, GL7 2AG
U.K.



RECIRCULATING GRAIN DRIER

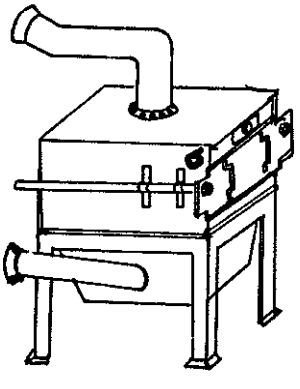
In order to dry the grain uniformly, it is alternately heated and cooled as it is passed in and out of the drying chamber. 5 models are available which can be used to dry paddy, wheat, soybean and maize. Each has a kerosene burner. The fuel consumption ranges from 0.5 to 5 litres per hour. The power requirement ranges from 1 to 3 horse power, and the capacity from 800 to 3000kg of paddy. Paddy dries in 13 to 15 hours with an efficiency of 0.8-1.2 per cent reduction of moisture per hour.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

MAIZE CRIB

This crib, 0.75m wide by 3m long, is illustrated above without the chicken wire on the front and back sides. These are put on during loading operations. Capacity 25 sacks. Rat guards on legs optional. Construction details from:

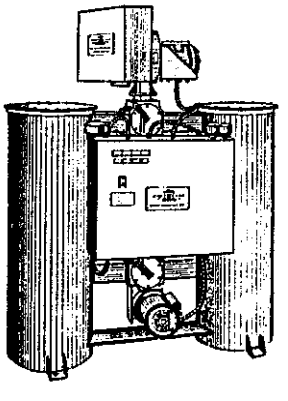
G.I.A.
Ricardo Matte Pérez 0324
Casilla 6122, Correo 22
Santiago
CHILE

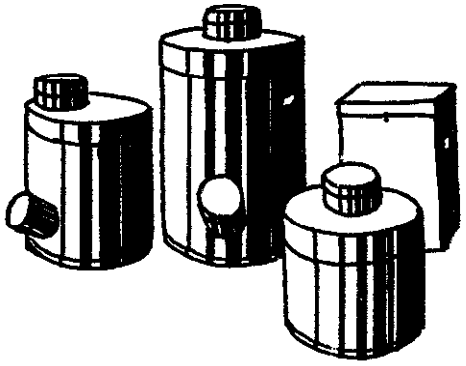


OSAW VEGETABLE SEED DRIER

The complete unit consists of a drying chamber and an OSAW dehumidifier DHF 400 with a humidistat (illustrated right). Hot air between 33°C and 43°C is passed through the seeds which are placed on a sliding tray enclosed in the drying chamber. The moisture is removed from the air in the humidifier and the dried air is again fed into the chamber until the seed moisture content reaches the desired level. The senior model (No.40570 illustrated left) has an air flow of 10,000 litres per minute, a power requirement of single phase 230V, 50c.p.s and a working capacity of 32kg per 24hrs at 22°C and 30 per cent R. A smaller model is also available.

ORIENTAL SCIENCE APPARATUS WORKSHOP
Jawaharlal Nehru Marg
Cantt 133 001, Haryana
INDIA





STORAGE BINS

GRAIN STORAGE BINS Steel cylindrical bins with capacities 1.2, 3 or 5qtls (illustrated left).

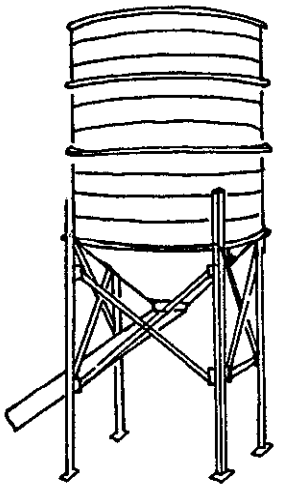
MAHARASHTRA AGRO IND. DEV. CORPORATION LTD.
Rajan House, 3rd Floor
Near Century Bazar, Prabhadevi
Bombay 400 025
INDIA

ELTEX GALVANIZED CORN BIN Four sizes are available from 100 to 500kg.

GEORGE H. ELT LTD.
Eltex Works, Bromyard Road
Worcester WR2 5DN
U.K.

GALVANIZED FEED BINS Three models with capacities from 0.14 to 1.1m³.

DAVID RITCHIE (IMPLEMENTS) LTD.
Whitehills, Forfar, DD8 3EE
U.K.

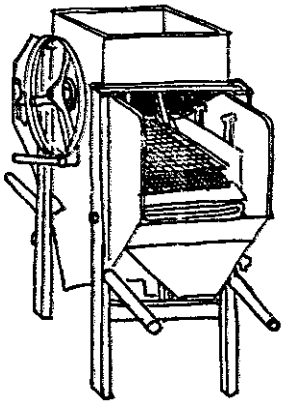


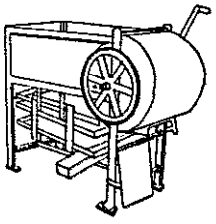
ELEVATED GRAIN AND MEAL STORAGE BINS

Elevated storage bins may be used for keeping either grain or animal feeds dry and safe from vermin. The outlet is situated at the conical base and has the advantage of being self-cleaning. The fact that the outlet is situated above ground level is convenient for loading and distribution operations. The Cossul bins are illustrated above. A wide range of storage capacities are available.

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

LAW EXPORT LTD.
Quarry Road, Chipping Sodbury
Bristol BS17 6AX
U.K.

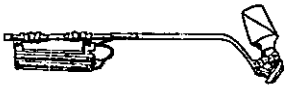




GRADER-CUM-WINNOWER

This machine is capable of grading all sorts of grains, pulses, oil seeds etc, whilst winnowing them at the same time. It can be operated by hand or by ½hp electric motor. Capacity: 200 to 300kg/h.

KISAN KRISHI YANTRA UDYOG
64 Moti Bhawan, Collectorganj
Kanpur 208 001
INDIA



FUMIGATORS

MINI—FLYDOWNER ultra low volume sprayer (illustrated).

TURBAIR LTD.
Britannica House
Waltham Cross
Hertfordshire EN8 7DR
U.K.

LIQUID INSECTICIDE APPLICATOR Twin diaphram pump mechanism driven by a small electric motor.

E. ALLMAN & CO. LTD.
Birdham Road, Chichester
Sussex P020 7BT
U.K.

(see also *Crop protection and operator safety* — Section 5)

CLEANERS/GRADERS

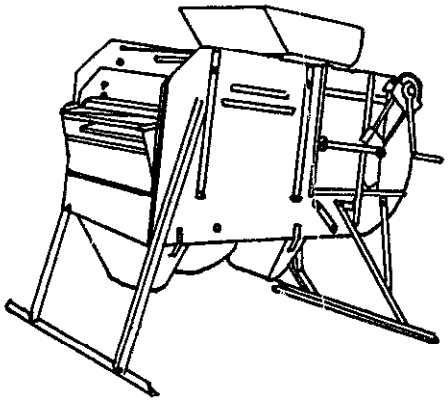
Designed to reclean grain after winnowing (in a thresher/winnower) and also to select seeds for sowing.

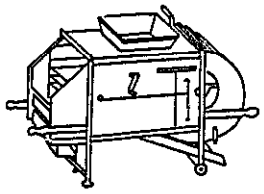
QUEME SEPARATOR Manual or motor driven. 3 cleaning grids. Adjustable ventilation; agitator in hopper (illustrated above).

SISMAR
B.P.3214, 20 Rue Dr. Theze
Dakar
SENEGAL

CLEAN-O-GRADE HAND 3 Sieve sorter. Hand- or motor-driven. Weight 65kg. Up to 2m³/h of market-clean cereals throughput (illustrated right).

OBBINK
Postbus 123
7100 AC Winterswijk
NETHERLANDS

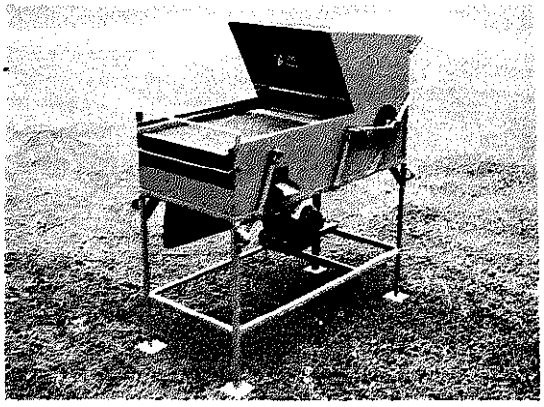




M-305/D GRAIN CLEANER

Output — up to 600kg/h. Hand- or power-operated (minimum 1.1kW) Weight 130kg. 4 carrying handles and 2 small riding wheels. Manufactured by Agromet-KMRL, Lublin and available through:

AGROMET MOTOIMPORT
Foreign Trade Enterprises
P.O. Box 990, Warsaw
POLAND



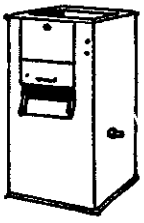
IRRI PORTABLE GRAIN CLEANER

Powered by a 0.5hp electric motor or a 1.0hp petrol engine, this equipment can clean up to 1000kg/h of sorghum, paddy, mungbean etc. The design is simple, consisting of a single shaft and a horizontal oscillating screen and fan.

ALPHA MACHINERY & ENGINEERING CORP
P.O. Box 579 MCC
Makati, Metro Manila, D708
PHILIPPINES

JCCE INDUSTRIES
242 Mayondon
Los Baños, Laguna
PHILIPPINES

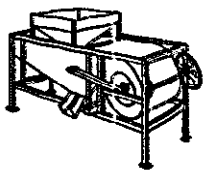
POYING'S WELDING SHOP
262 National Hi-Way
Brgy. Anos, Los Baños, Laguna
PHILIPPINES



POLISHED RICE CLEANER

For removing sand, dust, grit, bran etc. from polished rice. Two models are produced with low power requirements and capacities of 1200 and 1800kg/h.

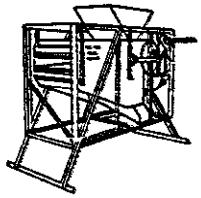
CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN



3 SIEVE SEPARATOR

The 3SW/2 (illustrated) is a hand-operated 3-sieve winnower which may be driven by an electric motor or engine. A wide choice of screens are available for different seeds. The capacity is 2 tonne grain/h.

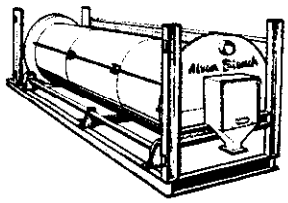
ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.



CROP BOY

A 3-sieve cleaning machine with interchangeable sieves for different kinds of cereals and seeds and adjustable air flow. The capacity is 1-2m³/h of clean cereals.

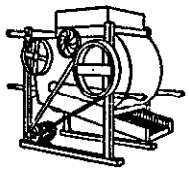
OBBINK
Postbus 123
7100 AC Winterswijk
NETHERLANDS



HIGH CAPACITY INDENTED CYLINDERS

Perforated cylinder separators 4.2m long which can be arranged in tiers of 1, 2 or 3. Capacities range from 2600 to 3800kg/h for cereals and 250-500kg/h for grasses.

ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.



CEREAL CLEANING MACHINE VP-46

This machine can either be hand operated or power driven. It cleans 8 to 10 sacks/h of wheat, soybean and corn or 6-8 sacks/h of rice. Interchangeable screens are available for different grains.

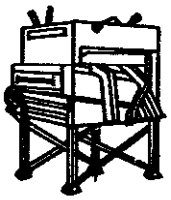
G.K.S. (COMPANHIA DE COMÉRCIO EXTERIOR)
Av São Luiz, 172
3° andar 90.000
Porto Alegre, RS
BRAZIL

TWO SCREEN GRAIN-SEED CLEANER CUM GRADER

Model CL3 is a 1hp machine with a capacity 300 to 600kg. It is fitted with a bottom blast fan with adjustable air blast to enable cleaning of large and small seeds.

A larger model is also available.

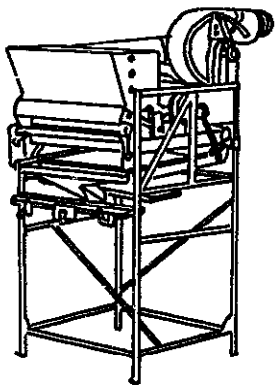
COSSUL & CO. PVT. LTD.
123/3/7 Industrial Area
Fazalganj, Kanpur, U.P.
INDIA



PC-10 PRE-CLEANING AND SORTING MACHINE

An all steel machine with aspiration and oscillation action for cleaning, sorting and grading most kinds of seed.

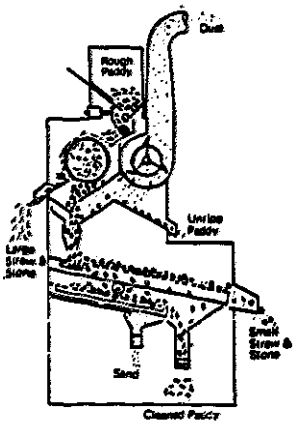
A. KISLUK
Industrial Zone
Afula Elit 18101, P.O. Box 166
ISRAEL



MEDIUM CAPACITY 2-SIEVE PRE-CLEANER

The model 2SA/4 is a 2-sieve single aspiration pre-cleaner with an output of up to 4 tonnes/h. It is more efficient for cleaning dried grain than wet grain. It is constructed entirely of steel with an aspiration fan V-belt driven by a 1hp electric motor (alternative engine drive available) also driving oscillating mechanism of the sieve shoes. Grain is fed into the input hopper and falls onto the top screen where the aspiration fan is regulated to remove the lighter particles which are expelled. The top sieve removes straws and sticks which are directed down a rubbish chute. The bottom sieve removes smaller particles of rubbish from the grain.

ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.



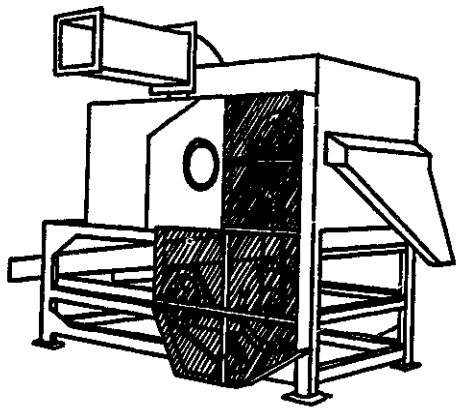
PADDY CLEANER

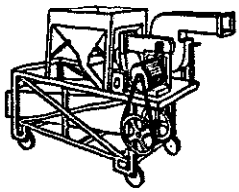
The Model SPC 20 is designed to remove impurities such as dust, sand, stones and weeds before the grain is sent through the milling process. It is built entirely of steel and can clean any type of grain at a rate of 1000-2000kg/h. The cleaning process shown in the diagram is in three stages:

a. Rotoscalper removes straw and other fibrous material
b. Aspirator with fan removes dust
c. Vibrating screen separates stones, sand, weeds and other small matter. The cleaned grain can be fed to an elevator or collected in a suitable receptacle.

The machine requires either a 4hp diesel engine or a 3hp electric motor.

SOMASIRI HULLERS MANUFACTORY
18 Parakrama Avenue
Kohuwala, Nugegoda
SRI LANKA





GRAIN PURIFIER

A grain cleaner for removing large stones, chaff, hessian dust, immature grains etc. It requires a 1hp electric motor or 1.85hp petrol engine and can clean 1 to 1½ tonnes grain/h.

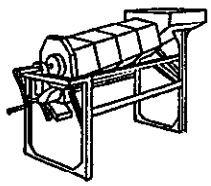
KISAN KRISHI YANTRA UDYOG
64 Moti Bhawan, Collectorganj
Kanpur 208 001
INDIA

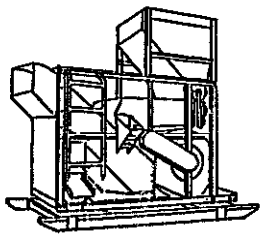
GROUNDNUT CLEANERS

THE SENEGAL SCREEN A rotary cleaner made by Sismar (above right) which can be operated by hand, this machine has a double sieve designed to separate groundnuts from husks and other rubbish. It is fitted with a large hopper, having a capacity of 80kg (approximately one sack), and two outlet spouts allowing the independent or simultaneous filling of two sacks. Output is 1500 to 2000kg/h. The sieve axle is mounted on ball bearings. Recommended turning speed is 15rpm. Weight 212kg.

DAROU SEPARATOR Used for cleaning unshelled groundnuts and all cereals by screening, grading and blowing. It requires a 3hp electric motor or 4hp engine and cleans 2500 to 3000kg/h. (Below right).

SISMAR
B.P. 3214
20 Rue Dr. Theze, Dakar
SENEGAL





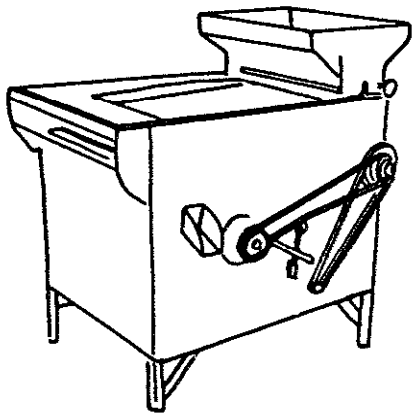
CLEAN-O-MATIC

This machine removes impurities such as husk, chaff and dust from grain and seed before it is sent to retail markets or further processing.

The grain is fed through a feed hopper onto a 'rota scalper'. This is a wire mesh cylinder which separates out the large impurities. The rest of the material passes through the cylinder onto a vibrating screen. A blower removes dust and other light particles.

The entire system is driven by electric motors. Four models are available with capacities varying from 5 to 20 tonnes grain/h.

THERMAX (INDIA) PVT. LTD.
Thermax House
4 Bombay Pune Rd., Shivajinagar
Pune 411 005
INDIA



SEED GRADER

The Hindsons Seed Grader cleans and grades wheat, gram, maize and barley. Its throughput is between 600 and 1100kg/h, with a power consumption of 0.4hp. It has a voltage requirement of 220-250V.

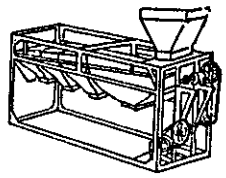
It is made of mild steel with overall dimensions of 1375mm (length) × 1480mm (height) × 880mm (width).

4 screens are provided, two of which are in use at any one time. They have circular holes of the following diameters: 2.8mm, 3.2mm, 3.6mm and 4.4mm. They are provided with a brush cleaner.

The hopper has a capacity of 66kg of wheat. A side-plate is provided for regulating the feed to the screens.

Movement is controlled by a rack and pinion arrangement. The blower is driven by 2 V-belts.

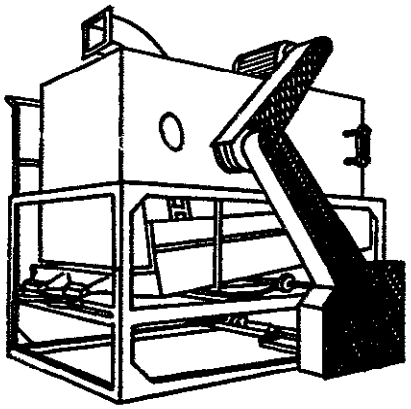
HINDSONS PVT. LTD.
The Lower Mall
Patiala 147 001, Punjab
INDIA



ECCENTRIC VIBRATING GRADER

Beans such as shelled peanuts, soybeans etc. are divided into 5 grades: large, medium, small, half size and broken ones. Two models are available with weights 250kg and 210kg, power requirements 1hp each and capacities 1000kg/h and 800-1000kg/h.

CECOCO
P.O. Box 8
Ibaraki City, Osaka Pref. 567
JAPAN



POWER-OPERATED CLEANERS

GRADE-O-MATIC Seed cleaner-cum-grader (illustrated).

THERMAX (INDIA) PVT. LTD.
Thermax House
4 Bombay Pune Rd.
Shivajinagar, Pune 411 005
INDIA

GRAIN-SEED CLEANER CUM GRADER Models CL147B and CL168B. 3 or 5hp (400-440v, 50Hz). Up to 800kg or 2 tonnes grain/h output.

COSSUL & CO. PVT. LTD.
123/367 Industrial Area
Fazalgunj, Kanpur, U.P.
INDIA

STONER DST-1 Output 5.5 tonnes/h. Power 5hp. Manufactured by Dae Ryuk Mechanical Ind. Co. Ltd., Korea, and available through:

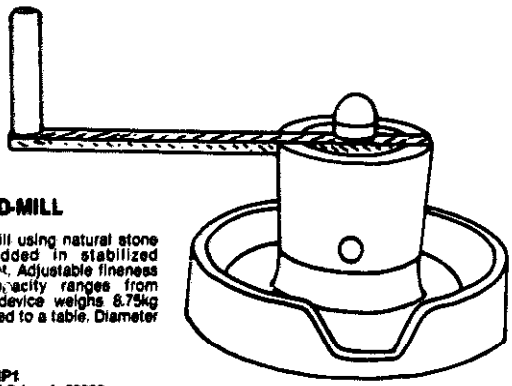
KOREA TRADE PROMOTION CORPORATION
C.P.O. Box 1621, Seoul
KOREA

GRAIN CLEANING MACHINES Models 1-P5A 100/1 and PPSA 160/1. Output 8 and 15 tonnes/h. Power 2 and 3hp. 4 larger models available with outputs ranging from 15-30 tonnes/h or 30-60 tonnes/h for pre-cleaning and power consumption 5-10hp.

G.K.S. (COMPANHIA DE COMERCIO EXTERIOR)
Av São Luiz, 172
3° andar 90 000
Porto Alegre, RS
BRAZIL

GRAIN CLEANER EA-FT 200, 50 tonnes/h. Power supply 220/380V.

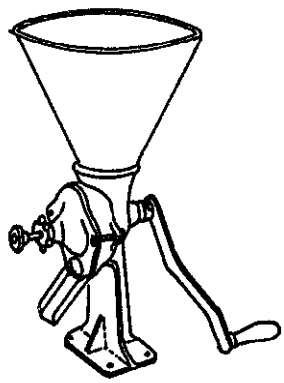
ASE EUROPE N.V.
Century Centre
de Keyserlei, 58 Box 1
B-2018 Antwerp
BELGIUM



STONE HAND-MILL

A vertical axis mill using natural stone granules embedded in stabilized magnesite cement. Adjustable fineness of grinding. Capacity ranges from 1.8-4.6kg/h. The device weighs 8.75kg and can be secured to a table. Diameter 28cm.

S.A.M.A.P.
1 rue de Moulin BP1
Andolsheim, Neuf-Brisach 68000
FRANCE



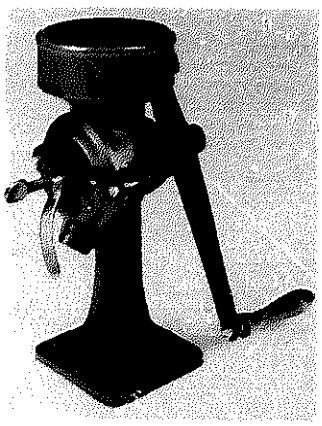
HAND-OPERATED GRAIN MILLS

SMALL DOMESTIC MILL All grains can be ground by this mill (left) wheat, barley corn, millet, all plant products and even chemicals. It is hand-operated and produces 20-30 litres per hour.

ETS. CHAMPENOIS, S.A.
Chamouilley, 52170 Chevillon
FRANCE

BURR MILL Cracks or fine grinds small grains. Output is about 4.5kg/h.

DUPLEX MILLS & MANUFACTURING CO.
415 Siglet Street
Springfield P.O. Box 1266
Ohio 45501
U.S.A.



HAND GRAIN MILLS

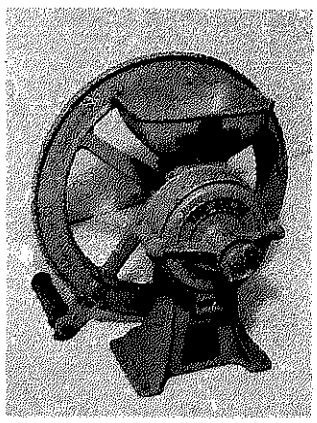
HAND GRIST MILL This tough cast iron mill (left) grinds all dry materials, such as shelled corn, beans, peas, coffee and grains of like size. It also makes cornmeal and wholemeal flour. Output is about 10kg/h.

C.S. BELL CO
170 W. Davis Street
Box 291, Tiffin, OH 44883
U.S.A.

DALTON, COOPER & GATES CORP.
205 West 34th Street
New York, NY 10001
U.S.A.

GRAIN AND CORN MILLS 4 similar models are available, with standard or high hoppers and metal plates or grinding stones. They can grind wheat, corn, nuts, seeds etc.

R & R MILL CO. INC.
45 West First North
Smithfield, Utah 84335
U.S.A.



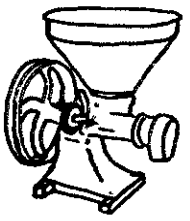
ATLAS NO. 1 HANDPOWER GRINDING MILL

A robust hand-operated mill suitable for grinding all types of dry grain, rice, coffee, spices and some industrial products. The mill is made in cast iron. There are very few wearing parts other than grinding plates, which are made of a special wear-resisting metal to give long service.

The mill will grind 7 to 9kg grain per hour depending on the fineness of the sample required and the speed at which the handle is turned. If a very fine sample is required, the meal should first be ground coarsely and then ground again with the grinding plates at their closest setting.

- height to top of hopper: 508mm; diameter of flywheel: 508mm; weight of complete mill: 34kg;

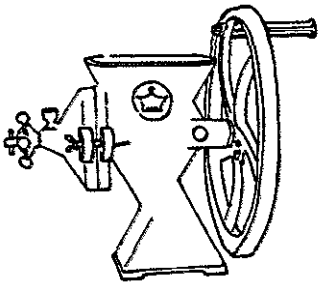
R. HUNT & CO. LTD.
Atlas Works, Earls Colne
Colchester, Essex CO6 2EP
U.K.



TYPE S CEREAL BREAKER

Suitable for crushing maize, rice, barley, beans etc. for poultry or cattle feed. Can be turned by hand or by a 4hp motor. Capacity 5-50kg/h. Net weight 20kg.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

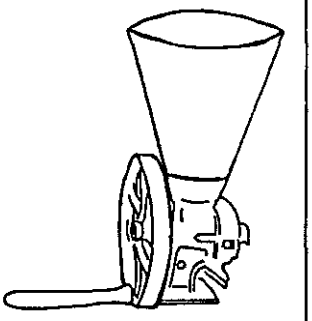


TYPE D.525 DOMESTIC HAND MILLS

The casing of this type of mill is made of cast iron. The hopper contains approximately 1.2kg of grain. The mill casing and cover have long main thrust bearings and the joint surface of the stationary disc is precision made. The shaft includes a feeder worm which ensures uniform feeding of the mill and at the same time pre-crushes the grain. The mill has only two lubrication points (lubrication should be checked each 2-3h when motor driven and daily when hand operated). The grinding discs are easily adjusted and are replaceable. Output between 7 and 18kg/h when hand operated and between 18 and 50kg/h when motor driven. Weight 23kg.

PRESIDENT MØLLERMASKINER A/S
DK-4300 Holbaek
DENMARK

ABC HANSEN COMP A/S
Hauchsvej 14, Post Box 3054
DK 1508 Copenhagen V
DENMARK



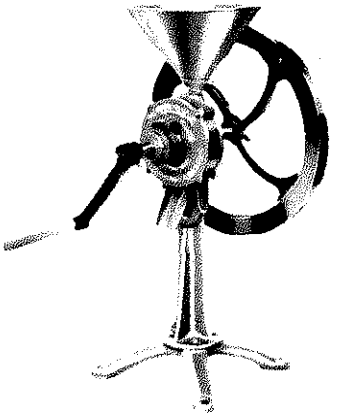
HAND/POWER MILLS

GRAIN GRINDER Chaff-cutters of New Zealand have produced this solid, cast-iron, small, grain grinder (illustrated above). The variable adjustment enables it to be converted from a rolling to a grinding action to produce coarse flour. The hopper is removeable. It can be powered by hand or using a 4hp electric motor. Dimensions are ¼ cubic metres and weight 23kg.

CHAFF-CUTTERS (NZ) LTD.
P.O. Box 11, Ngatea
NEW ZEALAND

TYPE HD and TYPE NO. 2 HAND MILL Cecoco produce these two types of mill which have outputs of between 5 and 50kg/h. The upper limit can be achieved when using the optional motor drive.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN



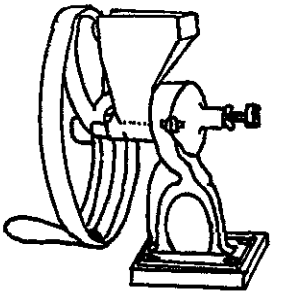
ATLAS NO. 3 HANDPOWER GRINDING MILL

Hand powered 2-operator grinding mill (left) for all kinds of dry grain. 190mm diameter grinding plates. Output up to 20kg/h. Mounted on cast iron column or four steel legs.

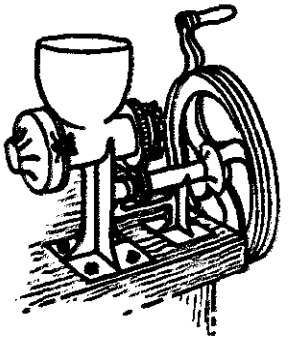
R. HUNT & CO. LTD.
Atlas Works, Earls Colne
Colchester, Essex CO6 2EP
U.K.

AB MINI MILL

The AB Mini Mill (right) is the smallest of the plate mills, designed for easy hand operation with a 380mm diameter flywheel and specially hardened cast steel. The flywheel and handle can be removed and be replaced by a 0.5hp electric motor. Output is between 22 and 30kg/h for the hand operated version and 30 to 100kg/h for the motorized version. The weights of these bench mounted models are 12 and 17kg respectively.



ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts, SN16 9SG, U.K.

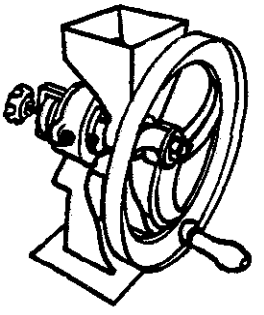


AVI STONE MILLER

The AVI Stone Miller grain grinder is specifically designed to make it easy to grind wheat into fine flour in one grinding. Although primarily designed for hand-power, this mill is extremely efficient when driven with an external power source. Heavy reinforced cast iron construction gears are machine cut for smooth, noiseless operation, and provide a 2:1 reduction for easy grinding. 8kg, 406mm diameter flywheel/handle. Stones are 127mm in diameter and fed by a cast auger. Adjustment from coarse to fine is with a positive-lock control. Hopper holds 8 cups (1.8kg) of grain. Height above table is 381mm. Total weight is approximately 25kg.

This mill is now manufactured with a 19mm tapered roller bearing (located just in front of the large gear) which supports the auger shaft.

PHOENIX FOUNDRY
Box 68, Marcus, WA 99151
U.S.A.



SMALL GRAIN MILLS

TYPE B100 This mill (left) is made of cast iron with steel plates. A screw adjusts for fineness of flour. Recommended speed is 80-150rpm. Output can be up to 30kg/h.

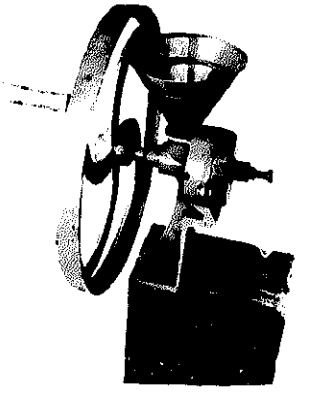
S.E.C.A.
38260 La Cote St. André
FRANCE

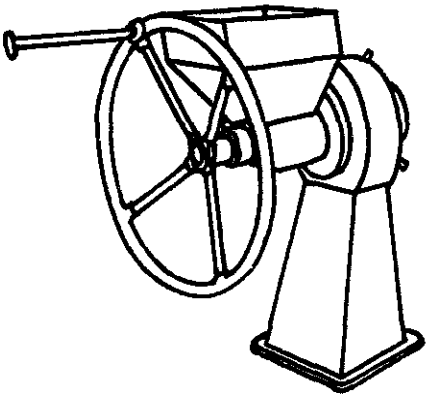
CORN CRUSHER A similar model is produced by Renson. The hand-wheel is 380mm diameter by 40mm wide.

RENSON ET CIE
BP 23, 59550 Landrecies
FRANCE

MINI-GRINDER This grinder (right) has interchangeable grinding wheels, 90mm in diameter made of special cast iron.

ETS. A. GAUBERT
22 rue Gambetta
BP 24, 16700 Ruffec
FRANCE



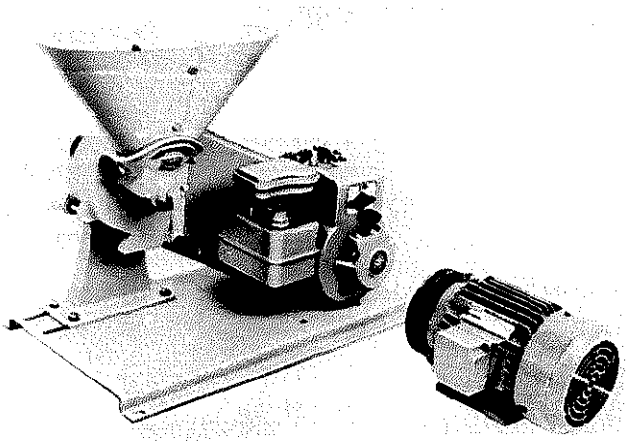


DUNIA HAND-OPERATED GRINDING MILL

The Dunia is a sturdy hand mill designed in Africa for grinding maize, wheat, coffee and other foodstuffs. The all-welded steel construction ensures a long life and is superior to mills manufactured of cast iron. For cleaning and inspection all that is needed is the removal of three finger-tight wing nuts on the face. No spanners are required. The welded 508mm steel hand wheel is robust and easily managed when grinding. Simple and strong, the Dunia hand-operated grinding mill is suitable for all grain grinding operations.

Ndume guarantee a ready supply of spare parts.

NDUME PRODUCTS LTD.
P.O. Box 6, Gilgil
KENYA



POWER-OPERATED GRINDING MILLS (BENCH MODELS)

These mills work on a similar principle to the hand-operated grinding mills, but are driven by a small motor. Below are listed the manufacturers of various types of grinding mill.

AMUDA DOMESTIC MILL Driven by a 0.5-1hp electric motor or a 1.95hp Villiers Engine, this cast-iron mill has an output of 5-20kg/h. It can also be adjusted for hand operation.

RAJAN UNIVERSAL EXPORTS (MFRS.) PVT. LTD.
Post Bag 250, Madras 600 001
INDIA

CHILLED BURR TYPE FLOUR GRINDING MILLS General-purpose mills suitable for grinding all grains and also chemical materials. Capacity ranges from 60-160kg/h for Type D (0.25-0.5hp) up to 200-900kg/h for Type A (3hp).

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

NUMBER 60 MODEL POWER MILL Steel alloy mill suitable for grinding all dry grains. It is powered by a 1-2hp electric motor and has an output of 45-130kg/h.

C.S. BELL CO.
170 W. Davis Street
Box 291, Tiffin OH 44883
U.S.A.

PREMIER 127 GRINDING MILL Small mill for wet or dry grinding of grain, tomatoes, peppers, spices, etc. Hand-operated auger feed to enable multiple grinding for extra fineness. Operated by petrol/kerosene engines or electric motor, capacity up to 100kg/h (illustrated above).

R. HUNT & CO. LTD.
Atlas Works, Earls Colne
Colchester, Essex CO6 2EP
U.K.

POWER-OPERATED GRINDING MILLS (FREE STANDING)

A range of sturdy free-standing mills suitable for grinding most grains. Outputs range from approximately 100-600kg/h, with the capacity of the machines largely determined by the moisture content of the material. These mills are commonly driven by electric motors from 1-8hp.

'JUNIOR' & 'SENIOR' 170 FLOUR MILLS 1-2hp and 3hp with capacities of 100-200kg and 150-400kg respectively.

ETS. A. GAUBERT
22 rue Gambetta
BP 24, 16700 Ruffec
FRANCE

ARGOUD VERTICAL MILLS Four mills from 2-5hp with capacities ranging between 80-450kg/h.

S.E.C.A.
38260 La Cote St. André
FRANCE

FLOUR MILL B31 A 4-6hp motor gives a capacity of 400kg/h (illustrated above right).

STE. COMIA-FAO SA
27 bd. de Châteaubriant, BP 91
35500 Vitré
FRANCE

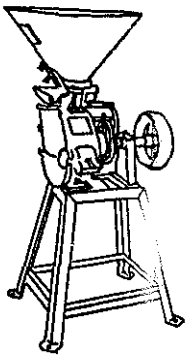
SUPERB MILL A power requirement of *5hp gives an output of 500-600kg/h.*

BENTALL SIMPLEX LTD
Heybridge Works, Maldon
Essex CM9 7NW
U.K.

AMUDA FLAT PLATE GRINDING MILL 1A A capacity of 180kg/h for dry material at 4-5hp.

RAJAN UNIVERSAL EXPORTS (MFRS.) PVT. LTD.
Post Bag 250, Madras 600 001
INDIA

AB CHELWORTH MILL Capacity approximately 250kg/h when driven by 5.5hp electric motor.



ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.

A320 & SILEX NO. 3 CEREAL MILLS Capacities approximately 600-1000kg/h and 350-600kg/h when driven by 4hp and 6-8hp motor, respectively.

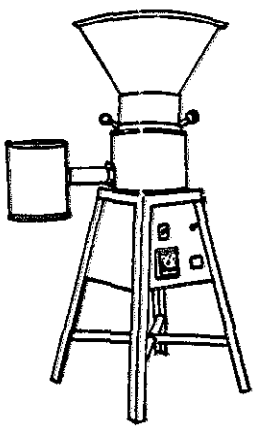
RENSON ET CIE
BP 23, 59550 Landrecies
FRANCE

PREMIER 1A and 2A GRINDING MILLS Output up to 300kg/h with a power requirement of 5-7hp.

R. HUNT & CO. LTD.
Atlas Works, Earls Colne
Colchester, Essex CO6 2EP
U.K.

D.S. STYLE GRINDING MILL A 6-8hp mill with a capacity of 230-270kg/h.

DANDEKAR BROTHERS
(Engineers & Founders)
Sangli-Shivaji Nagar, 416 4[illegible]
Maharashtra
INDIA



VERTICAL AXIS GRINDING MILLS

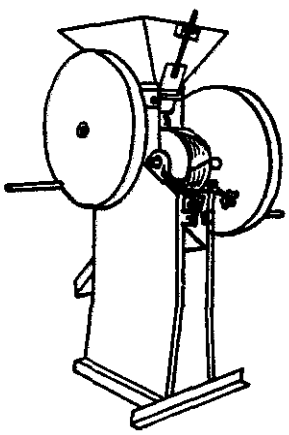
A range of heavy duty vertical axis grinding mills suitable for *small commercial use. The S.A.M.A.P. model is illustrated above.*

KISAN KRISHI YANTRA UDYOG
64 Moti Bhawan
Collectorganj, Kanpur 208 001
INDIA

S.A.M.A.P.
1 rue du Molin BP 1
Andolsheim
Neuf-Brisach, 68600
FRANCE

A.B.C. HANSEN COMP A/S
Hauchsvej 14, Post Box 3054
DK 1506 Copenhagen V
DENMARK

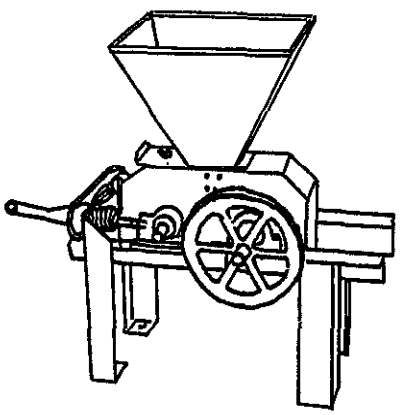
MASCHINENFABRIK HEGER GmbH
Zaberstraße 26
7093 Herrenberg 1
W. GERMANY



HAND-OPERATED ROLLER MILL

This roller mill has been designed as part of a seed oil extraction system. In principle its action is similar to the motorized roller mills which follow. It is powered by two people operating the hand cranks at either side of the mill. A third person is required to feed the mill and to relieve those operating it. Reasonable throughputs can be achieved.

TRAAS METAAL B.V.
Groene Kruisstraat 3
4414 A L Wserde (2)
NETHERLANDS



SMALL ROLLER MILLS

'LITTLE BRITCHES' ROLLER MILL Suitable for the small feeder, with a power requirement of 1hp and a capacity of 350-700kg/h for oats and 450-750kg/h for maize (illustrated).

H.C. DAVIS SONS MFG. CO. INC.
P.O. Box 395
Bonner Springs, Kansas 66012
U.S.A.

DRY GRAIN CRUSHING MILL Capacity ranges from 100-250kg/h with a power requirement of 2hp.

STE COMIA-FAO SA
27 bd de Châteaubriant, BP 91
35500 Vetré
FRANCE

YN221 DOUBLE-ROLLER GRINDER & 6F-1728A MILL MODELS With power requirements of 5 and 3kW, output is 400kg/h (based on cotton seed) and 120-140kg/h of grain respectively.

CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing
CHINA

MODEL FG-61 A feed grinder with a power requirement of 2-4hp and a capacity of 200-325kg/h.

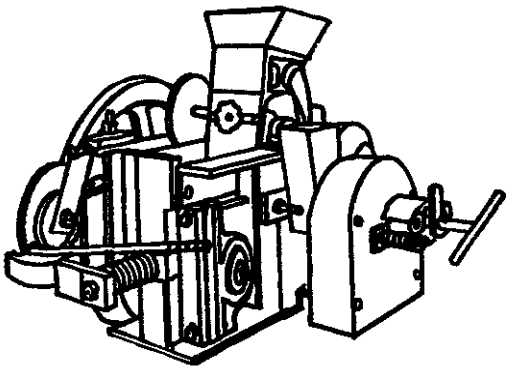
CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

TYPE A 180 An economical 3hp electric motor yields 300-700 litres/h.

ELECTRA
47170 Poudenas
FRANCE

GRAIN ROLLER TYPE GH 374 A 3hp mill with capacity of 200-400kg grain/h.

ETS. A. GAUBERT
22 rue Gambetta, BP 24
16700 Ruffec
FRANCE



ROLLER MILLS

R16 ROLLER UNIT The R series of roller mills are designed for mounting on meal mixers or for independent installation.

The (illustrated) R16 unit is suitable for rolling low fat grains, i.e. it is not suitable for rolling beans and maize. Powered by either a 5.5 or 7.5hp motor, output is between 280 and 350kg/h. The diameter of the rollers is 22.5cm. The R24 and R30 models have power requirements of up to 15hp with outputs up to 1800kg/h.

ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.

MFG-125 FLOUR MILLING MACHINE This model is designed specifically to process wheat from small collective farms. The grains are fed by a slow revolving roller to an interface with a fast revolving roller, where they are ground. Manufactured by Tong-xian flour milling machine works and available through:

CHINA AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing
CHINA

Further roller mills with power requirements ranging from 3-7.5hp are manufactured by the following:

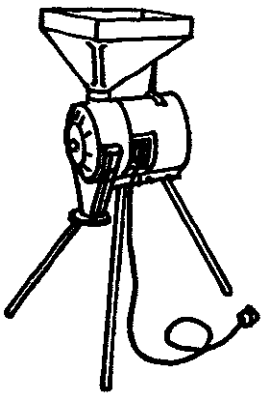
S.E.C.A.
38260 La Cote St. André
FRANCE

LAW EXPORT LTD.
Quarry Road, Chipping Sodbury
Bristol BS17 6AX
U.K.

KONGSKILDE U.K. LTD.
Holt, Norfolk, NR25 6EE
U.K.

MASCHINENFABRIK HEGER GmbH
Zaberstraße 26
7033 Hemmenberg 1
W. GERMANY

RENSON ET CIE
BP 23, 58550 Landrecies
FRANCE



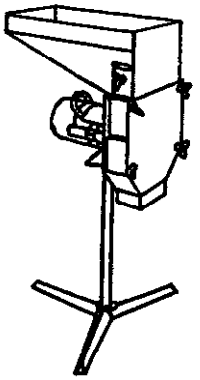
M-5/71 HAMMER MILL

This Yugoslavian hammer mill is constructed with a built-in 0.5hp electric motor. The motor speed is set at 2800rpm. It is single phase with a safety switch. Milling fineness is easily obtained by exchanging sieves. The capacity of this hammer mill varies from 50 to 200kg/h, depending not only on the fineness of sieve used but also on the moisture content of the grain. A set of five sieves are provided with fineness of 2, 3, 4, 5, and 6. It weighs 30kg.

M-5/R

This second model is similar to but larger than the M-5/71. It also has a built-in single-phase electric motor with safety switch, and two PTO shafts, one powering the feed mill. The other, by means of a pulley and a V-belt can be used for powering other attachments. The motor output is 1.5hp at 2800rpm. It weighs 40kg.

MIO STANDARD — OSIJEK
Vukovarska 219a, Osijek
YUGOSLAVIA



SMALL HAMMER MILLS

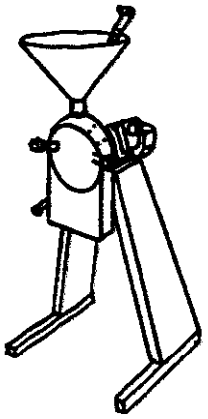
These motor-driven stand-alone hammer mills can be used for grinding grain especially for animal and poultry feed. They require a power input of between 1.5 to 3hp provided either by an electric or petrol-driven motor. The rapidly rotating and swinging hammers reduce the particle size of the dry material until fine enough to pass through the interchangeable perforated screens.

MINI MILL Electra produce a range of mills with outputs of between 80 and 300kg/h according to the fineness of screen. The mini mill is illustrated left.

ELECTRA
47170 Poudenas
FRANCE

POPULAR HAMMER MILL This is a 3hp electrically-powered hammer mill.

SCOTMEC LTD.
42-44 Waggon Road
Ayr, Scotland
U.K.



PICOLLO HAMMER MILL

A suitable mill for small and medium-sized concerns. All kinds of grain, maize, corn cob and damp maize can be milled.

Technical data

Type	Picollo 1	Picollo 2
height	145cm	145cm
width	85cm	85cm
height of outlet	62cm	62cm
weight	120kg	130kg
motor power	4hp	5.5hp
	Throughput in kg per hour	
maize	*350*	*450*
damp maize	*750*	*900*

MASCHINENFABRIK HEGER GmbH
Zaberstraße 26
7033 Hemmenberg 1
W. GERMANY

Similar to this is the NOFLAYE 2.

SISMAR
BP 3214
20 Rue Dr. Thase, Dakar
SENEGAL

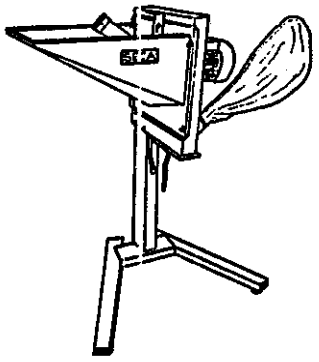
FLOUR MILLS

TEXAS FLOUR MILL S.E.C.A. produce this model (illustrated right) powered by a 5.5hp motor. It weighs 80kg with a maximum output of 700kg/h of maize. There is an optional 200 litre mobile container.

S.E.C.A.
38260 La Cote St. André
FRANCE

BP 2000 GRINDING MILL This model has a 35 litre hopper with flow adjusting hatch and a magnetic device for removing foreign bodies. The rotor is fitted with 9 reversible hammers with disc containing 3 cutting edges for the pre-grinding of corn husks. A 300rpm 5.5 or 7.5hp motor, 9 sieve sizes available. Weight up to 91kg. Output from 500-800kg/h.

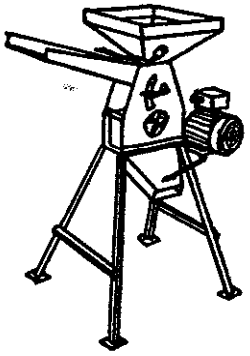
STE. COMIA-FAO S.A.
27 bd. de Châteaubriant, BP 91
35600 Vitré
FRANCE



BLOC SERIES ELECTRICAL GRINDERS

As part of a wide range of mills and milling equipment, this small mill can be supplied with a plate or hammers. It has a 5.5hp motor at 3000rpm. It is suitable for attachment to a grain bin, but legs can be supplied.

LAW EXPORT LTD.
Quarry Road, Chipping Sodbury
Bristol BS17 6AX
U.K.



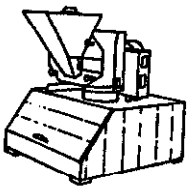
SMALL FLOUR MILLS

TYPE 'BABY' HAMMER MILLS These multipurpose mills (illustrated left) have a very high rotation speed in the mill chamber of 6000rpm. The 6 reversible hammers are 8mm wide. It is built entirely of steel. Powered by motors from 4-7.5hp, or by a tractor PTO, most models are stand-alone but one model comes complete with a 450 litre bin on which the mill is mounted.

ELECTRA
47170 Poudenas
FRANCE

GFC — 308 DISC MILL This mill rotates at 4600rpm, powered by a 4hp electric motor. It is similar in appearance to the Electra Baby Mill but with the motor mounted at the base of the legs.

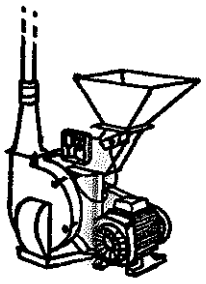
CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing
CHINA



DYNAMILL

The Dynamill can be mounted on a flour or meal hopper as shown in the illustration above. This model available in 7.5 or 10hp versions with outputs from 200 (fine milling) to 2000 (crushing)kg/h. Other versions available.

ASE EUROPE N.V.
Century Centre
De Keyserlei 58, Box 1
B-2018 Antwerp
BELGIUM



FLOOR-MOUNTED HAMMER MILLS

5X HAMMER MILL President mills come with a wide range of standard fittings including 4 different mesh screens. The 5X (illustrated above) engine capacity is 4-5.5kW; conveyor length is 35m and throughput about 250kg/h. The 10X engine capacity is 5.5-7.5(-11)kW; conveyor length is 45m and throughput about 450kg/h. A fully automated intake control can be mounted to ensure the motor does not overload.

PRESIDENT MØLLERIMASKINER A/S
DK-4300 Holbæk
DENMARK

BABY MIRACLE MILL 4 versions of this model are available. Mill chamber speed 6000rpm; output 250 to 400kg/h.

S.E.C.A.
38280 La Cote St. André
FRANCE

SERIES F6 The mill chamber is 15cm in diameter. The power required ranges from 7.5 to 15hp using 8 or 12 hammers.

ELECTRA
47170 Poudenas
FRANCE

STOCK MILL The stockmill grinds maize, cassava, all cereals, oyster shells, peas, beans, rice, corn cobs, straw, chalk etc. It has a large diameter rotor and a mill chamber lined with percussion bars. A blower system enhances the flow of meal through the screen and constantly cools the mill chamber. It has a 75 litre hopper and the feed is protected by a powerful permanent magnet, which traps metal objects. Shock absorbers are supplied as standard equipment. The specially tempered steel hammers may be turned round so as to use all four corners. This makes it possible to mill over 120 tonnes of cereal before they need replacing. Output varies according to the power available, either a 7.5 or 10hp electric motor or a 12hp diesel motor can be provided. For five screen sizes, 0.8mm, output of maize is 150-220kg/h or 525kg/h for cassava. For coarse screen sizes, 5mm output can rise to 950kg/h for maize. Shipping volume is 2.2m³.

ASE EUROPE N.V.
Century Centre
de Keyserlei 58, Box 1
B-2018 Antwerp
BELGIUM

ESSEX MAJOR HAMMER MILLS Hammer mill available in four sizes 3, 5.5, 7.5 and 10hp. The largest (illustrated in the introduction to this section) is capable of grinding over one tonne per hour. Push button start and automatic stop provided. Swing hammer design takes only 30 seconds to switch production from fine to coarse meal — the time taken to change the screens (2.5, 3.0 and 5.0mm). High volume fan will deliver ground meal 20m

Model hp	Output of ground barley through 3mm screen kg/h
3	100
5.5	200
7.5	275
10	375

CHRISTY & NORRIS LTD.
Kings Road, Chelmsford
Essex, CM1 1SA
U.K.

ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.

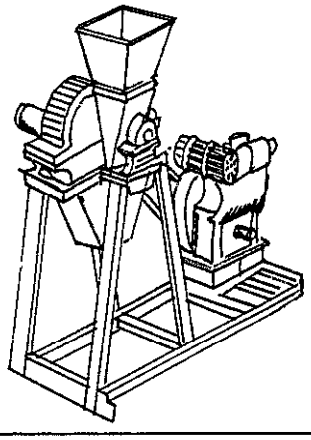
HAMMER MILLS

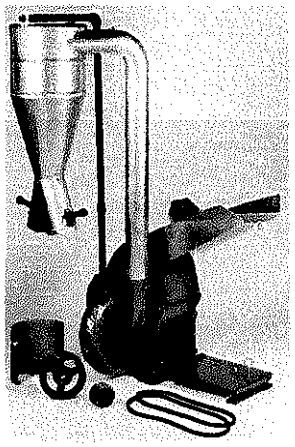
No. 1 DISINTEGRATOR This hammer mill (right) is designed specifically for pounding dried cassava for a garifying process. It uses a 5hp 2250rpm diesel engine. Its throughput is about 150kg/h. Made from steel plate it weighs 98kg.

P.T. KERTA LAKSANA
Jl. Jenderal Sudirman 504
Bandung
INDONESIA

TOY MILL This mill has been developed specially for use in the tropics. It requires an electric motor of 4.5 to 5.5hp or a larger diesel or petrol engine. It comes in two types of package: the basic machine, similar to that illustrated right, but with an electric motor — weight 210kg; or a properly protected and guarded machine together with a petrol or diesel engine — weight 436kg.

RENÉ TOY & CIE
BP 10, 41800 Montoire-S-Le-Loir
FRANCE





HAMMER MILLS WITH CYCLONE BAGGERS

The manufacturers listed below all produce a range of hammer mills similar to that illustrated (above) made by C.S. Bell Co. The power ranges are given, where known. All include blowers which deliver the meal or flour into a cyclone bagger, on left, which usually has two bagging discharge spouts. Capacities of the cyclone can be adjusted to suit the client. The photo (above right) is a view inside of the hammer mill showing the staggered, free-swinging hammer arrangement with the blower on its left.

BLOWER DISCHARGE HAMMER MILL 3 models: 3, 5, 15hp.

C.S. BELL CO.
170 W. Davis Street
Box 291, Tiffin, OH 44883
U.S.A.

DALTON, COOPER & GATES CORP.
205 West 34th Street
New York, NY 10001
U.S.A.

TITAN 2000 HAMMER CRUSHER Power required: 7.5, 10, 12.5hp. Bagging cyclone 1700 litres, hopper 1000 litres.

STE COMIA-FAO S.A.
27 bd. de Châteaubriant, BP 91
35500 Vitré
FRANCE

MODELS TN1, 2, 4, 8 Power required: from 5 to 30hp.

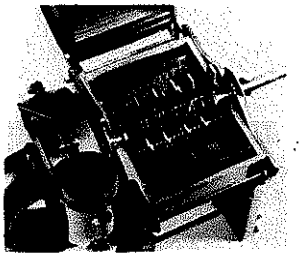
NOGUEIRA IRMÃOS SA
Rua XV de Novembro 781
P.O. Box 7
13970 — Itapira, São Paulo
BRAZIL

MP-75 HAMMER MILL 32 hammer model, 10hp required.

PENAGOS HERMANOS & CIA LTDA.
Calle 28, No 20-80
Apartado Correos 689
Bucaramanga
COLOMBIA

FEED GRINDER Power required: 10hp

GARDNERS CORPORATION
6 Doctors Lane



(Near Gole Market), P.O. Box 299
New Delhi 110 001
INDIA

MODEL MH & MM Power required: from 0.75 to 60hp

MACESA — MAQ. CEREXA SA
Camino de Iturrigorri 3
Bilbao 2
SPAIN

ALPHA HAMMER MILL Power required: from 3 to 25hp.

ALPHA MACHINERY & ENGINEERING CORP
P.O. Box 579 MCC, Makati
Metro Manila, D708
PHILIPPINES

HIPPO HAMMER MILLS Power required from 6-22.5hp

PRECISION GRINDERS LTD.
53, Craster Road, Southerton
P.O. Box 1790, Harare
ZIMBABWE

POSHO MILL Power required: 8 to 40hp.

RELIANCE ENGINEERING WORKS LTD.
P.O. Box 197, Kisumu
KENYA

GRINDING MILL Power required: 8 to 60hp.

MANIK ENGINEERS
P.O. Box 1274, Arusha
TANZANIA

STANDARD HAMMER MILLS Power required: 7.5 to 50hp.

KONGSKILDE U.K. LTD.
Holt, Norfolk NR25 6EE
U.K.

HAMMER MILL 570 42 hammers.

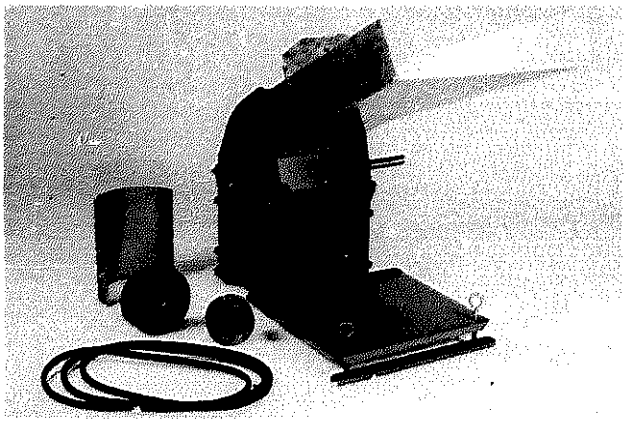
AUSTRALIAN AGRI. MACH. PTY. LTD.
73 Abernethy Road
Belmont W.A. 6104
AUSTRALIA

NEWMAN JUNIOR NM50 Also available NM75 and NM100.

UNITED ENGINEERING WORKS LTD.
P.O. Box 3082, Factory Area
Arusha
TANZANIA

TYPE VS1 6000rpm rotor speed; 460 litre bagging cyclone.

ELECTRA
47170 Poudenas
FRANCE



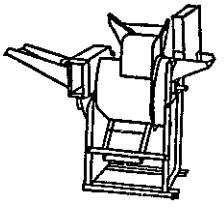
BOTTOM DISCHARGE HAMMER MILL

For dry grains and wet pulpy products this mill can be mounted on a hopper or auger or be raised to allow a barrow or tub to be placed beneath it. The bottom of the mill is completely open for full and rapid discharge. The basic package consists of the mill, feed-regulating table, 6mm screen (or other size specified), motor mounting bracket, V-belt and pulleys for 1800rpm power source.

The Bell bottom discharge hammer mill is available in three sizes.

Model No.	Weight	Capacity (shelled) maize)	hp required
10 mill	65kg	250kg/h	2-3
20 mill	74kg	500kg/h	3.5
30 mill	88kg	2500kg/h	7.5-10

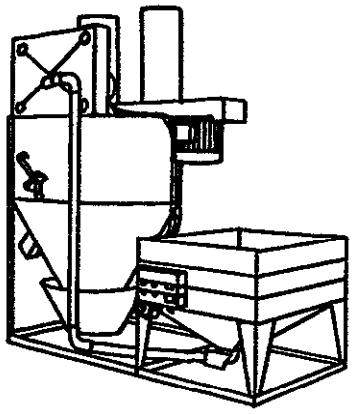
C.S. BELL CO.
170 W. Davis Street
Box 291, Tiffin, OH 44883
U.S.A.



TRIMAQ 200 HUSKER/SHELLER/GRINDER

This three-in-one hammer mill, with husking, shelling and chopping attachments, can produce coarse or fine flour with or without the husk or cob. 7-9hp motor or tractor PTO.

CIA PENHA MAQ. AGRÍCOLAS
Av. Brazil 1724, C.P. 477
Ribeirão preto
BRAZIL



MILL AND MIXER UNITS

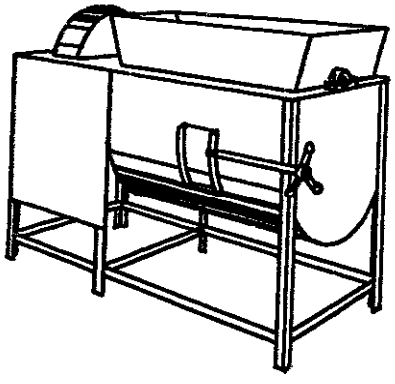
Below are listed two manufacturers of different types of mill and mixer units.

MILL AND MIXER INSTALLATION 4K-JU 500 The installation contains a mixer of capacity 500kg with a 2hp motor, and a hammer mill of capacity 300kg with a 5.5hp motor (illustrated left).

PRESIDENT MOLLERIMASKINER A/S
DK-43000 Holbaek
DENMARK

MIX 'N ROLL MACHINES 6 models are available with capacities ranging from 450-3600kg, mixer motors 5-25hp and roller mill motors all 5hp.

DUPLEX MILLS & MANUFACTURING CO.
415 Siglet Street
Springfield P.O. Box 1268
Ohio 45501
U.S.A.



HORIZONTAL FEED MIXERS

HORIZONTAL MIXER The mixing chamber has a capacity of 1.5m³ and can handle wet or dry materials (illustrated left).

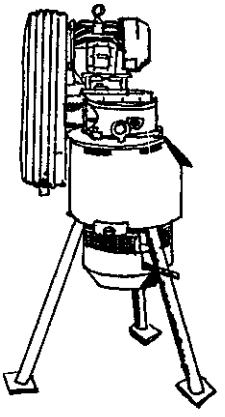
GARDNERS CORPORATION
6 Doctors Lane
(Near Gole Market), P.O. Box 299
New Delhi 110 001
INDIA

2, 4, AND 6-WAY PROPORTIONERS Outputs from 350 to 1200kg/h and motors from 3-10hp.

R.A. LISTER FARM EQUIPMENT LTD.
15 Gosditch St., Cirencester
Gloucestershire, GL7 2AG
U.K.

1200 LITRE MIXER A load is mixed in about 5 minutes.

ELECTRA
471170 Poudenas
FRANCE



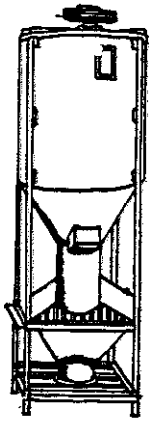
FARM PELLETING PRESSES

Stock feed mixes are compressed into pellets of 6 sizes ranging from 2.4-16.0mm diameter. The motor supplied runs at 10hp, but 5 and 7.5hp motors are available. Many accessories are available. Forage (grass etc.) can be pelleted, after being premilled, and mixes with less than 5 per cent molasses can be pelleted. Various manufacturers of different types of pelleting press are listed below. The Lister press is illustrated.

R.A. LISTER FARM EQUIPMENT LTD.
15 Gosditch St., Cirencester
Gloucestershire, GL7 2AG
U.K.

LAW EXPORT LTD.
Quarry Road, Chipping Sodbury
Bristol BS17 6AX
U.K.

OBBINK
Postbus 123
7100 AC Winterswijk
NETHERLANDS



VERTICAL FEED MIXERS

Listed below are various manufacturers of different types of vertical feed mixers.

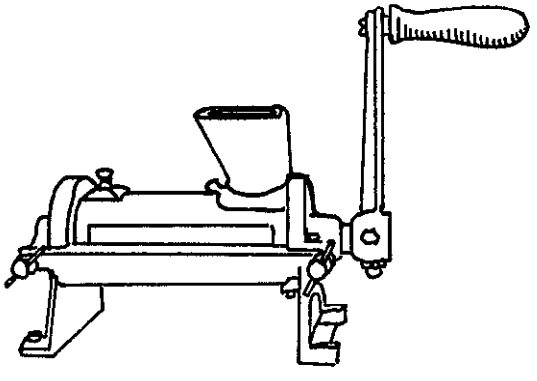
RATION MIXER 3 models are available in the range 600-2000kg/h output. They can be run by electricity (1-3hp), petrol (4.9hp) or diesel oil (4-7hp) (illustrated left).

NOGUEIRA IRMÃOS SA
Rua XV de Novembro 781
P.O. Box 7
13870 — 1 Itapira, São Paulo
BRAZIL

VERTICAL MIXERS Manufacturers of similar mixers in the range 3-9hp include:

A. KISLUK
Industrial Zone
Afula Elit 18101 P.O. Box 195
ISRAEL

LAW EXPORT LTD.
Quarry Road, Chipping Sodbury
Bristol BS17 6AX
U.K.

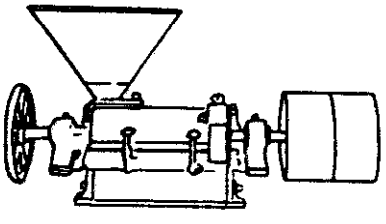


JAVA HAND-POWERED RICE HULLER

This is a small machine intended for the grower of small quantities of rice paddy, and for domestic use. Paddy can be shelled at a maximum rate of about 14kg of paddy an hour, but the capacity may vary considerably depending on the type of paddy and its condition. The machine has three adjustments controlling the feed, the discharge and the hulling knife. A perforated plate allows dust to escape, and the machine can be opened easily for cleaning. Strongly made, it weighs 10.5kg net and is provided with holding-down screws and spanners.

JOHN GORDON & CO. (ENGINEERS) LTD.
198a High Street, Epping
Essex CM16 4AG
U.K.

ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.



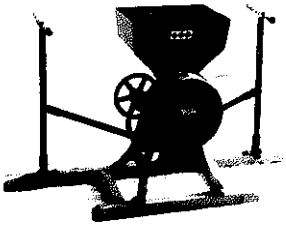
ENGELBERG-TYPE RICE HULLER

These power-driven metal roller rice hullers are used worldwide. A specially chilled, hard, cast iron or steel cylinder shell is rotated inside a double hardened huller screen. The degree of milling is controlled by the outlet flow rate and the adjustment of the huller blade. Can be supplied with polishers and winnowers.

Power required from 3-15hp for outputs of cleaned rice of 30-300kg/h from paddy or 70-600kg/h from shelled rice.

RAJAN UNIVERSAL EXPORTS (MFRS.) PVT. LTD.
Post Bag 250, Madras 600 001
INDIA

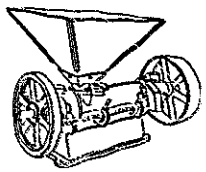
ENGELBERG HULLER CO. INC.
Export Office, 75 West Street
Syracuse, New York
U.S.A.



TWO-MAN RICE HULLER

Two men pull the hand levers and rotate the huller at about 3000rev/min. Output 250kg/h at 90 per cent hulling efficiency. Weight 60kg.

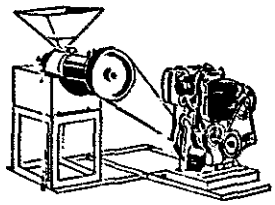
CECOCO
P.O. Box 6
Ibaraki City, Osaka 567
JAPAN



GRANTEX RICE HULLERS

Hulling is performed by a chilled, hard, cast iron cylinder rotating inside a screen. The degree of milling is controlled by adjustment of the outlet slide and of the huller blade. Two models are available of power requirements 12 and 15hp and capacities of up to 200 and 290kg/h respectively.

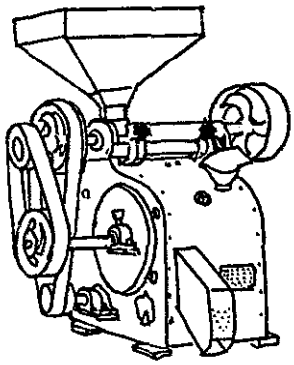
LEWIS C. GRANT LTD.
East Quality Street, Dysart
Kirkcaldy, Fife KY1 2UA
U.K.



NEWMAN RICE HULLER

Suitable for shelling and whitening rice and other grains such as maize. It is equipped with a single cast iron cylinder and regulated by an outlet slide and huller blade. The power required is 9hp and output i . 250kg/h of polished rice.

UNITED ENGINEERING WORKS LTD.
P.O. Box 3082, Factory Area
Arusha
TANZANIA



RICE MILLS

Various manufacturers of different types of rice mill are listed below.

'RUANG THONG' RICE MILLER These 5 'spacious bin' models are available running at between 2 and 15hp and with outputs ranging from 50-400kg/h. They can spin and crush rice, chaff and rice husks. The problem of the grains breaking can be reduced and overcome by adding thiamine which is also a useful vitamin (illustrated left).

THAI TAVORN
549/33-36 Satupradit Road
Yannava, Bangkok
THAILAND

'MIRACLE' RICE MILLING MACHINE 150-200kg/h of paddy are milled to make polished clean white rice. The bran is collected and can be used for cleaning purposes. The power consumption is 5hp (electric motor) or 6hp (diesel motor).

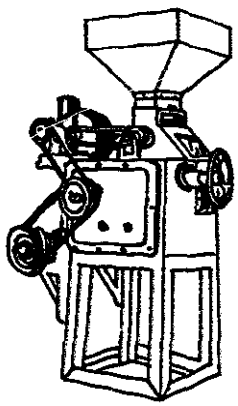
YONTPHISAL FACTORY
101 Rajdamnern Road
A. Muang, Trang
THAILAND

'FOUR-SEPARATIVE' RICE MILL Two models are available for husking and polishing. The paddy is separated into rice, fine chaff, husks and husk tips. Manufactured by Luxi Farm Machinery Plant, Hunan and available through:

CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing
CHINA

IRON CYLINDER RICE HULLER This type of mill can be used for hulling, milling or polishing. There are 4 models which range from 5 to 15hp. The output from paddy ranges from 36-38 to 135-305kg/h, and from shelled rice ranges from 72-126 to 500-595kg/h.

TOOLS AND AGRICULTURAL MACHINERIES LTD.
P.O. Box 1940, Colombo 10
SRI LANKA



2-TONNE RUBBER RICE HULLER

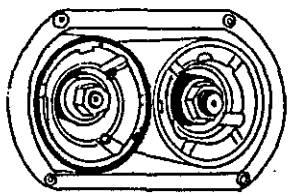
Grain is fed from the hopper between two rubber rollers rotating at different speeds in order to remove hulls gently from the paddy. It is powered either by a 5hp motor drive or by an engine, installed separately. More than 500kg/h of hulled rice can be produced. The rollers are 22cm in diameter (illustrated left).

JASWINDER MECHANICAL WORKS
G.T. Road, Tarn-Taran (Pb) 143 401
INDIA

RUBBER ROLL SHELLER

Two models of 7hp and 5hp are available with a single pair of helical gears and capacities of 1 tonne and ½ tonne of paddy per hour respectively.

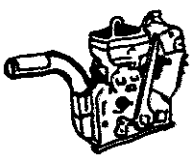
YESHWANT MECHANICAL WORKS
Kelkar Compound
Dahanu Road, 401 602
Maharashtra
INDIA



KISSAN RICE MILL RUBBER ROLLERS

These rubber rollers are available in several sizes for fitting to a roller mill, and are designed for de-husking rice.

DINESH RUBBER INDUSTRIES
Rustom Mills Compound
Dudheshwar Road P.B. No. 288
Ahmedabad 380 001
INDIA

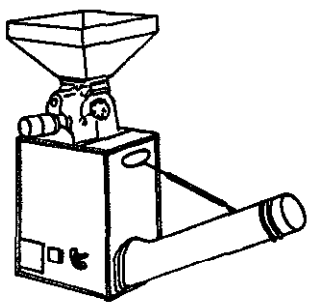


RUBBER ROLL HULLERS/WINNOWERS

Two manufacturers listed. Cecoco model is illustrated.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

SOMASIRI HULLERS MANUFACTORY
18 Parakrama Avenue
Kohuwala, Nugegoda
SRI LANKA



RUBBER ROLL HULLERS

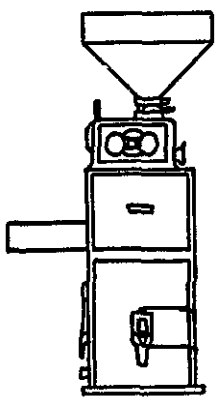
Two manufacturers of different types of rubber roll huller are listed.

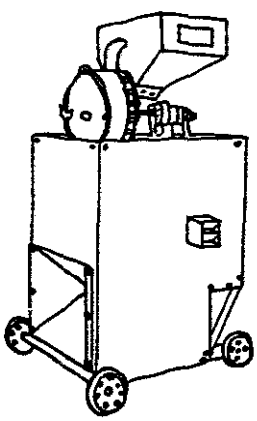
AGRINDO RICE HULLER This huller (illustrated left) has a capacity of one to two tonnes per hour. Power required 4 to 5hp.

P.T. AGRINDO
Desa Bambe Kab. Gresik
Jawa-Timur
INDONESIA

FRICTION TYPE COMBINATION SHELLER This huller (illustrated right) requires 4 to 5hp motor. It gently removes husk from the grain, retaining its shape. The machine's husk exit can throw about 1m on normal, full operation.

TOOLS AND AGRICULTURAL MACHINERIES LTD.
P.O. Box 1940, Colombo 10
SRI LANKA





RUBBER ROLL PADDY DEHUSKERS

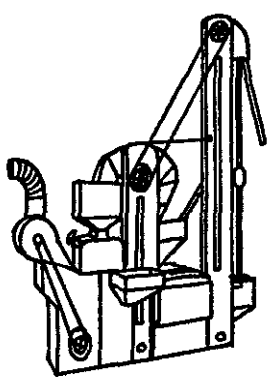
Many models are available; three are *itemized:*

CENTRIFUGAL (RUBBER) DEHUSKER WITH HUSK ASPIRATOR Capacity 400-500kg/h. Power required: 1hp electric motor.

DEHUSKER CUM SEPARATOR Capacity 400-500kg/h. Power required: 3hp electric *motor or diesel engine.*

COMPOSITE UNIT This is for automatic dehusking, polishing of and separation of unhulled paddy, rice bran, fuel and cattle feed. Capacity: 200kg/h. Power required; 5hp electric motor or diesel engine.

KISAN KRISHI YANTRA UDYOG
64 Moti Bhawan, Collectorganj
Kanpur 208 001
INDIA

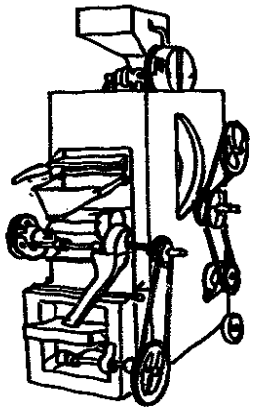


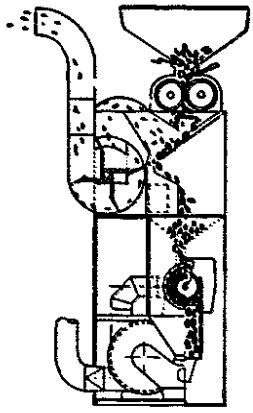
AUTOMATIC TYPE RICE HULLER SAH 1

This model (illustrated left) comprises a rubber roll huller, a husk winnower, an *auto separator and two bucket type* elevators to transfer grain to successive stages. The capacity is 1000-1500 kg/h of paddy.

The hulling unit has two gear-drive rubber rolls of the same diameter which counter-rotate at different speeds to ensure a uniform rotation against a constantly fluctuating load. There are *two wind channels; one a high velocity* channel which separates husk and unripe paddy from the rest and one a low velocity wind channel to separate the husk from the dead paddy. The 10 vibrating trays separate out the un-hulled paddy from the brown rice. The un-hulled rice is returned by one elevator to the huller. The other elevator discharges the *pure brown rice.*

SOMASIRA HULLERS MANUFACTORY
18 Parakrama Avenue
Kohuwala, Nugegoda
SRI LANKA





MINI RICE MILLS

MINI MILL This machine (illustrated above left) produces polished rice from paddy at a rate of 400-500kg/h of paddy. The power required is 10-15hp by electric motor or equivalent diesel engine.

KISAN KRISHI YANTRA UDYOG
64 Moti Bhawan, Collectorganj
Kanpur 208 001
INDIA

GARDNERS CORPORATION
6 Doctors Lane
(Near Gole Market), P.O. Box 299
New Delhi 110 001
INDIA

COMPACT RICE MILLING UNIT The Cecoco mill (diagram above right) contains a rubber roll rice huller and a steel roll rice polisher. One advantage of the unit is that these two can be used together or separately. The motor produces 5-7hp and an hourly capacity of 180-240kg of brown rice (380kg of paddy). The unit has a net weight of 160kg.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

RICE MILL UNIT KRM-500 The huller section has an output of 800-900kg/h and power requirement of 1-1.5hp. The polisher section has an output of 650-750kg/h and power requirement of 12-13.5hp. The total weight is 273kg.

SEA COMMERCIAL CO. INC.
3985 R. Magsaysay Blvd.
Sta Mesa, Manila 2806
PHILIPPINES

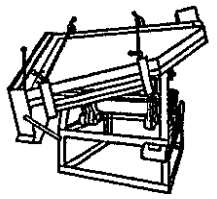
RICE HUSKER/POLISHER At the husker's outlet, the brown rice can be collected or it can be fed into the pearler. The power requirement is 10hp and the output 400-500kg/h (brown rice) or 250-300kg/h (pearled white rice).

ASE EUROPE N.V.
Century Centre
de Keyserlei 58, Box 1
B-2018 Antwerp
BELGIUM

HAND-OPERATED RICE SEPARATORS

Hulled and winnowed rice is separated into whole brown rice, paddy and broken and immature rice with the use of a woven wire net and an adjustable multi-plano-wire screen. The separator is used before the rice is polished. Four models are available: Capacities 600-100kg/h; weights 17-27kg.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

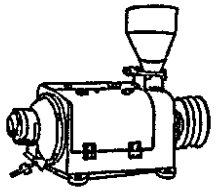


PADDY SEPARATORS

PADDY SEPARATOR (DPS-80) A 5-1hp separator with capacity 1000-1300kg/h. Speed 450rpm. Illustrated above. Manufactured by Dae Won Machine Work Co.

PADDY SEPARATOR (DS-4 with DST-4) Manufactured by Dae Ryuk Mechanical Ind. Co. Ltd.

KOREA TRADE PROMOTION CORPORATION
C.P.O. Box 1621, Seoul
KOREA



BARLEY POLISHER

There are two models:

	DB-1	DB-2
gross weight	235	205
capacity (kg/h)	180-200	150-170
power (PS)	20	17

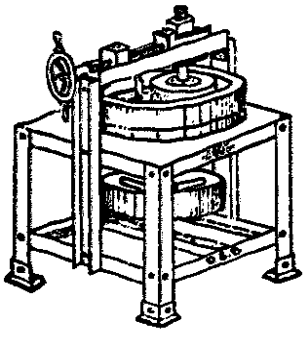
Manufactured by Dae Ryuk Mechanical Ind. Co. Ltd. and available through:

KOREA TRADE PROMOTION CORPORATION
C.P.O. Box 1621, Seoul
KOREA

RICE SEPARATORS

After hulling and winnowing, the delivered rice still contains a small proportion of unhulled paddy. The separators consist of one or two oscillating tilted trays which separate the paddy from brown rice. Output: up to 3t/h; Power: up to 4hp.

TOOLS AND AGRICULTURAL MACHINERIES LTD.
P.O. Box 1940, Colombo 10
SRI LANKA



RICE FLAKE MACHINES

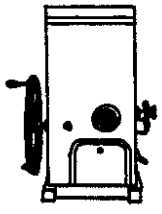
Rice flakes are made by soaking paddy overnight, and baking for 2 hours. Rice flake machines carry out the dehusking and flaking.

THE POHA MILL This mill (illustrated left) has an angle- and channel-iron frame, and is hand-operated.

DANDEKAR BROTHERS
(Engineers & Founders)
Sangli — Shivaji Nagar, 416 416
Maharashtra
INDIA

RICE FLAKES MACHINE Paddy is turned into rice flakes at a rate of 70-95kg/h (of paddy). The power consumption is 4hp. Roller diameter 30cm. Drum diameter 90cm.

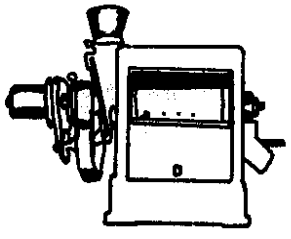
BEHERE'S & UNION INDUSTRIAL WORKS
Kalkar Compound, Dahanu Road,
Distt. Thane, Maharashtra 401 602
INDIA



CECOCO HAND RICE POLISHER

This polishes brown rice or paddy. The capacity is 10 to 15kg/h. ¼-½hp power drive also available. This increases the capacity to 30kg/h.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN



HORIZONTAL CONE TYPE ABRASIVE ROLL RICE POLISHERS

The following manufacturers produce, between them, nine types, all of which are air-cooled with capacities ranging from 300-2800kg/h and power requirements from 5-30hp.

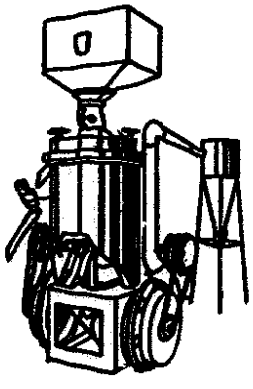
The Cecoco model illustrated above uses a constant airflow through the polishing chamber to keep the temperature down. The abrasive roller being conical increases in surface speed with increasing distance from the inlet. However the force of pushing rice towards the outlet decreases so that very little broken or unevenly polished rice is produced.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

P.T. YANMAR AGRI M/G
(P.T. YAMINDO)
42 Jl. Ir. H. Juanda, Jakarta
P.O. Box 4135/JKT
INDONESIA

Korean models are manufactured by Dae Ryuk Mechanical Ind. Co. Ltd. and Dae Won Machine Work Co. and available through:

KOREA TRADE PROMOTION CORPORATION
C.P.O. Box 1621, Seoul
KOREA



VERTICAL CONE TYPE RICE POLISHER MODEL SP2

This machine (illustrated left) polishes, pearls and delivers the polished rice and bran separately. It has a capacity of 750-1000kg/h and requires either a 10hp diesel engine or 8hp electric motor.

SOMASIRI HULLERS MANUFACTURING
18 Parakrama Avenue
Kohuwala, Nugegoda
SRI LANKA

RICE KING POLISHER

This is a vertical cone-type polisher with a capacity of 1-1½ tonnes/h. It requires a 6hp electric motor or 8hp diesel engine, and delivers the rice free from dust and bran.

TOOLS AND AGRICULTURAL MACHINERIES LTD.
P.O. Box 1940, Colombo 10
SRI LANKA

RICE POLISHER CUM DAL MILL

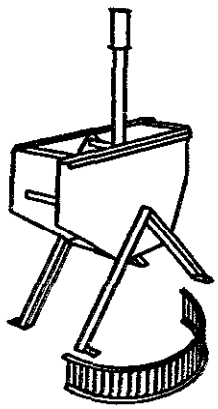
This has a simultaneous winnowing arrangement and can be used for preparing pulses of all types by using the dal attachment. Either 3hp electric motor or 5hp diesel engine required. 200 to 300kg of brown rice can be polished per hour.

KISAN KRISHI YANTRA UDYOG
64 Moti Bhawan, Collectroganj
Kanpur 208 001
INDIA

WHITE RICE CONE

This consists of a cast-iron grooved cone which rotates inside a wire gauze casing. It can be supplied with complete ball bearing system.

JASWINDER MECHANICAL WORKS
G.T. Road
Tarn-Taran (Pb) 143 401
INDIA



HAND-OPERATED ALTERNATING GROUNDNUT DECORTICATORS

The construction of these decorticators, which are used to remove the shells of groundnuts, comprises a pivoted rasp bar fixed at a critical distance above a concave sieve. The pendular motion of the rasp bar cracks the shells of the groundnut pods and the broken shell and whole nuts fall through the sieve. Most of these models have interchangeable sieves ranging between 8mm and 16mm.

A separate operation is required to separate the cracked shells from the nuts. This can be done by winnowing the pile of material that falls through the sieve. Secondly it is particularly important, for the confectionery trade, to separate the damaged nuts. This is less easy to perform mechanically, although a sieving/grading operation will be of assistance, and manual sorting is a more common solution.

These decorticators can shell about 100kg pods/h.

The Gaubert model is illustrated left. The Sismar model is illustrated right.

ETS A. GAUBERT
22 rue Gambetta, BP 24
16700 Ruffec
FRANCE

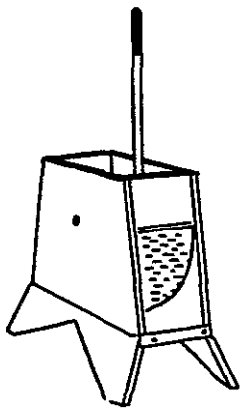
TROPIC
B.P. 708, Douala
CAMEROON

MODERN ENGINEERING COMPANY
1A Anna Street, Velandi Palayam
Coimbatore 641 025, Tamil Nadu
INDIA

UBUNGO FARM IMPLEMENTS
Box 20126, Dar-es-Salaam
TANZANIA

ZIMPLOW LTD.
HIS Steelworks Road
Box 1059, Bulawayo
ZIMBABWE

SISMAR
B.P. 3214
20 rue Dr. Theze, Dakar
SENEGAL



HAND-OPERATED ROTARY SHELLERS

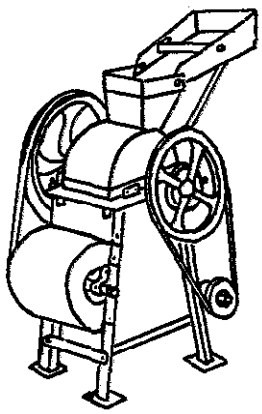
Threshed groundnuts are shelled by revolving wooden beaters and are separated by means of a roller-bar-screen and a fan. Any unshelled pods should be fed again into the machine. Breakage of kernels should only be about 2-3 per cent. Two types are listed.

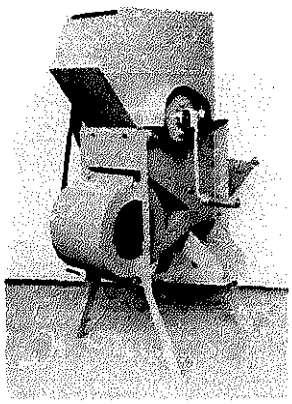
BABY TYPE This machine (illustrated right) can shell up to 2 bags of groundnuts per hour.

DANDEKAR BROTHERS
(Engineers & Founders)
Sangli-Shivaji Nagar 416 416
Maharashtra
INDIA

PEANUT HUSKING MACHINE 300 C This should be turned at about 35rpm. Its output is around 50kg/h.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN



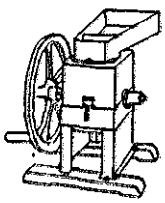


GROUNDNUT DECORTICATOR

This machine performs simultaneously a decorticating and cleaning operation. Threshed groundnut pods are placed in the hopper. The handle is rotated using one hand only. The other can be used to *regulate the flow of pods into the* decorticator. The kernels and cracked nuts fall out through the concave end. The hull is separated by the blower and clean kernels are discharged through the grain outlet. Ball/bush bearings with oil cups are standard fittings.

capacity	10-20kg/h
power	One person
length	730mm
width	570mm
height	950mm
weight	32kg

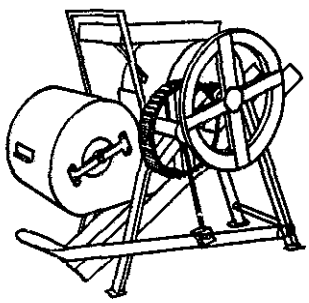
JYOTI LTD.
Bombay Shopping Centre
R.C. Dutt Road
Vadodara 390 005
INDIA



'COTTAGE' DECORTICATOR

Supplied with four sieves, 8mm, 9mm, 9.5mm and 10.75mm. Output is about 35kg of shelled kernels at 100rpm. It is advisable to sort the pods according to size before feeding into machine.

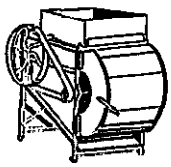
KIRLOSKAR BROTHERS LTD.
Udyog Bhavan, Tilak Road
Pune 411 002
INDIA



FOOT-OPERATED DECORTICATOR

A 76cm, 37 × 10mm paddle type lever forms the foot treadle of this machine. On one end of the lever a 100mm square *plate is fixed, to support the foot; at the* other end a bush pivot secures the lever to the frame of the sheller. A U clamp and bush connect the foot lever to the gear. The large gear has 70 teeth; the small gear has 20 teeth. The 4 blade winnowing fan has 23cm diameter. The *flywheel is made of cast iron and has* 40.5cm diameter by 50mm width. Weight, including stand is 65kg. Output 2qq/8 h day.

HINDSONS PVT. LTD
The Lower Mall
Patiala, 147 001, Punjab
INDIA

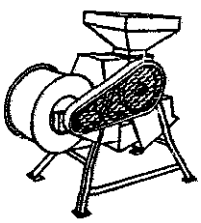


WIND MILL DECORTICATOR

SP Engineering model is illustrated. 2hp motor required; output 20 bags/h. Kirloskar's Kalayan-A model is similar, but also can be powered by 2 people; output: 300kg/h.

SP ENGINEERING CORPORATION
PB No 218
Kanpur 208 001
INDIA

KIRLOSKAR BROTHERS LTD.
Udyog Bhavan, Tilak Road
Pune 411 002
INDIA



SUPER CAYOR ROTARY SHELLERS

Output 150kg shelled nuts/h. Manual version or power-operated version (illustrated above).

SISMAR
B.P. 3214
20 Rue Dr. Theze, Dakar
SENEGAL

POWERED SHELLERS

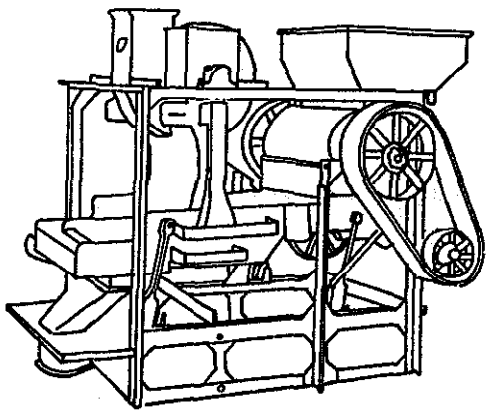
No. 539 5.5-8hp SHELLER This (illustrated right) is one of two models produced by SAMAT; No. 463 is a 1.5hp model similar to SISMAR's (illustrated left).

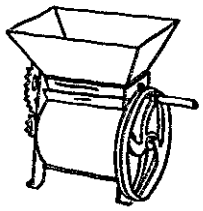
STE LES FILS DE LOUIS SAMAT
10 Boulevard De Frères-Godchot
13392 Marseille Cedex 4
FRANCE

SHERPUR DECORTICATOR The concave grate has square bars with 8mm gaps, and clearance from the rotor can be varied from 1 to 10mm. Screen holes are 15 × 8mm. Power required is 5hp. Also available 8hp Kirloskar model.

UNION FORGINGS
Focal Point, Sherpur
Ludhiana, Punjab
INDIA

KIRLOSKAR BROTHERS LTD.
Udyog Bhavan, Tilak Road
Pune 411 002
INDIA





HAND-OPERATED DRUM COFFEE PULPERS

TROPIC COFFEE PULPER Ripe coffee cherry is fed into the hopper where it is pulped between a cylinder and screen. This hand-operated machine is fly-wheel assisted (illustrated above).

TROPIC
B.P. 706, Douala
CAMEROON

ANGUH COFFEE PULPER Similar to the Tropic coffee pulper.

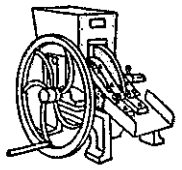
B.A. ANGUH AGRIC TOOLS INDUSTRY
B.P. 43, Bamenda
CAMEROON

McKINNON'S ATOM COFFEE PULPER A strong machine manufactured for the ideal treatment of Arabica and Robusta coffee. The approximate capacity of ripe coffee is 55kg/h. This model is not suitable for Liberica coffee for which McKinnon's recommend the special Liberica disc pulpers.

WM McKINNON & CO. LTD.
Spring Garden Iron Works,
Aberdeen AB9 1DU, Scotland
U.K.

BENTALL 'SUPER NOVA' Manual operation enables outputs of up to 300kg/h of fresh ripe coffee. (The power drive version has a capacity of 600kg/h.)

BENTALL SIMPLEX LTD.
Heybridge Works, Maldon
Essex CM9 7NW
U.K.



DISC COFFEE PULPERS

McKINNON 1 DISC COFFEE PULPER This machine is fitted with ball bearings, cast iron disc, fly-wheel and handle. Supplied complete with disc cover, and holding down bolts (illustrated above).

WM McKINNON & CO. LTD.
Spring Garden Iron Works
Aberdeen AB9 1DU, Scotland, U.K.

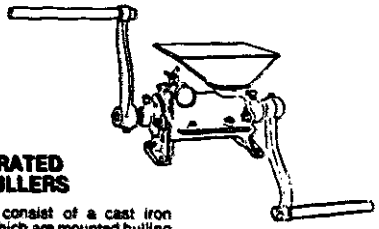
GORDON'S 'IRIMA-67' DISC COFFEE PULPER This small machine pulps coffee by squeezing the cherries between the rotating disc and the fixed pulping chop. The disc is of smaller diameter than standard and carries bulbs on one face only. Normally the disc has cast iron bulks of No. 75 pattern suitable for Robusta and Arabica coffees. Alternative discs are available for Arabica and Liberica varieties.

Capacity 270-360kg/h of ripe coffee which should be fed into the machine with water on the same day as it is picked. The machine weighs 25kg. Also Gordon's produce the L.C. series with 1-4 discs, all sizes having the same side-frame, underframe castings and sealed ball-bearings.

JOHN GORDON & CO.
(ENGINEERS) LTD.
196a High Street, Epping
Essex CM16 4AQ, U.K.

K. KAY COFFEE PULPER A range of wet processing coffee machinery including pulpers with 1-4 disc units.

K. KAY ENGINEERING
Box 18464, Nairobi, KENYA



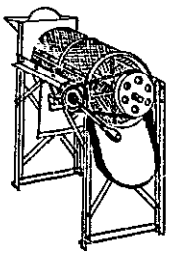
HAND-OPERATED COFFEE HULLERS

Coffee hullers consist of a cast iron casing inside which are mounted hulling blades.

THE 'BUKOBA' COFFEE HULLER is suitable for shelling dry cherry coffee (9kg/h) and parchment coffee (27kg/h), but is unsuitable for the treatment of Liberica coffee. The machine has no adjustments.

THE NO. 10 'AFRICA' COFFEE HULLER (illustrated above), which may also be driven by a 1.5hp motor, is suitable for a wide range of coffee types, although with hand power alone, dry cherry Liberica coffee is too difficult to shell. Arabica can be shelled at the rate of 22kg/h of clean coffee or 36kg/h of parchment coffee. Robusta rates are 30 per cent more; Liberica about 30 per cent less. Net weight 43kg.

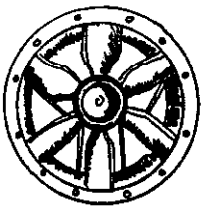
JOHN GORDON & CO.
(ENGINEERS) LTD.
196a High Street, Epping
Essex CM16 4AQ
U.K.



'CONGO' COFFEE GRADER

This grader has a capacity of 50kg/h and can grade many varieties of coffee.

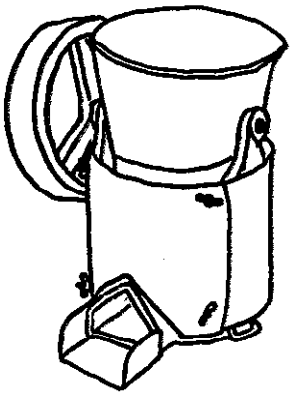
JOHN GORDON & CO.
(ENGINEERS) LTD.
196a High Street, Epping
Essex CM16 4AQ
U.K.



KAY FANS AND SKIN DRIERS

Manufactured to any capacity, axial and centrifugal fans are designed to suit the first stage of skin drying when control of air flow is critical to avoid parchment cracking.

K. KAY ENGINEERING
Box 18464, Nairobi
KENYA



POWERED COFFEE PULPERS

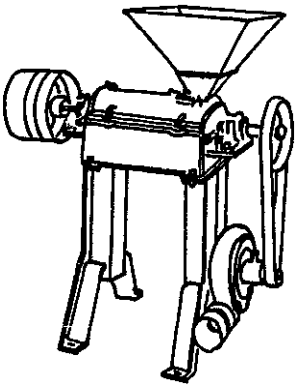
Below are listed two manufacturers of different types of powered coffee pulper.

DV-1406 COFFEE PULPER Pulps coffee cherries up to 2500kg/h. The coffee pulper is driven by a 1hp motor. It weighs 40kg (illustrated left).

PENAGOS HERMANOS & CIA. LTDA.
Calle 28, No 20-80
Apartado Carreos 689
Bucaramanga
COLOMBIA

McKINNON'S MULTIDISC COFFEE PULPER Output ranges from approx. 1000-4500kg/h with power requirements from 0.5-2hp.

WM McKINNON & CO. LTD.
Spring Garden Iron Works
Aberdeen AB9 1DU, Scotland
U.K.



'AFRICA' COFFEE HULLERS No. 2 and No. 5

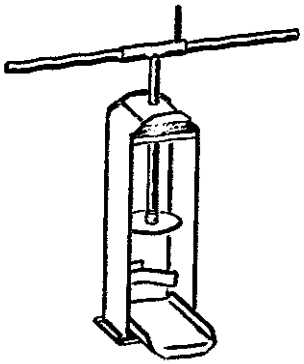
These hullers are capable of treating both dry cherry coffee and dry parchment coffee. Two screens are provided one perforated and the other of woven wire for treating these two types of coffee of all varieties.

Output kg/h	No. 2	No. 5
parchment coffee	325	170
dry cherry	227	116
power hp	6-8	3-4

WM McKINNON & CO. LTD.
Spring Garden Iron Works
Aberdeen AB9 1DU, Scotland
U.K.

JOHN GORDON & CO.
(ENGINEERS) LTD.
196a High Street, Epping
Essex CM16 4AQ
U.K.

BENTALL SIMPLEX LTD.
Heybridge Works, Maldon
Essex CM9 7NW
U.K.



OIL EXPELLERS

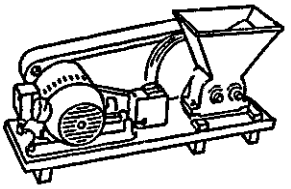
PALMOIL SCREWPRESS The hand-operated screwpress holds 8 litres. The maximum cake pressure is 40 bars, and after pressing the cake is expelled using the outer rim of the main body (left).

HYDRAULIC HANDPRESS The handpress holds 17, 11 and 8 litres of coconuts, oilseeds in general and sheanuts respectively. Based on a hydraulic lorry-jack (30 tonne), maximum cake pressure for above crops are 60, 90 and 125 bar, respectively.

TRAAS METAAL B.V.
Groene Kruisstraat 3
4414 A L Waarde (2)
NETHERLANDS

A similar hydraulic handpress is made by the Patian First Ag. Mach. Works, Fujian. Available through:

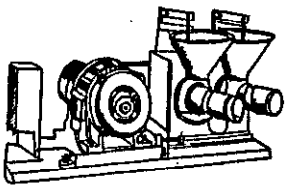
CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing, CHINA



OIL FRUIT CRUSHER AND PRESS

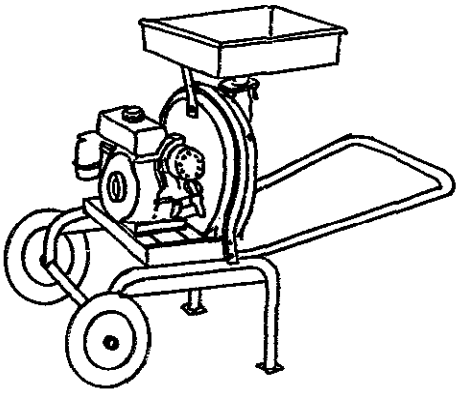
This is manufactured as a complete unit, operated by only one motor or in two separate parts, as illustrated.

OIL FRUIT CRUSHER This component (above left) crushes oil fruit into small pieces by a 'scissor-system'. This permits better pressing and prevents early oil efflux from the fruit. Driven by a 3-phase, 1.1kW electric motor gives an output of 100-300kg/h.



OIL FRUIT SPINDLE PRESS Fruits are not warmed prior to pressing in the press (above right). The press-head must however be heated by flame or hot water prior to operation. Power requirement 1.75-3.5kW with an output of 25-70kg/h. Manufactured by Komet in W. Germany and available through:

TECHNICAL ASSISTANCE (INTERNATIONAL)
P.O. Box 1224, Vosskuhlenweg 2
2072 Bargteheide
W. GERMANY



PALM NUT CRACKERS

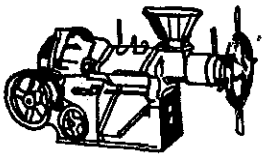
BARROW-MOUNTED PALM-NUT CRACKER Nuts are fed into a cracking chamber driven by a 3hp petrol engine and are rendered down into small pieces. Capacity 300-400kg per hour. This mill is mounted on wheels for mobility (left). A similar model is made by Alvan Blanch.

SISMAR
B.P. 3214
20 Rue Dr. Theze, Dakar
SENEGAL

THE 'AMUDA' MOBILE PALM-NUT CRACKER The legs swivel into a horizontal position, for easy transport by two people — stretcher fashion. A 1.5hp motor gives outputs up to 500kg/h.

RAJAN UNIVERSAL EXPORTS (MFRS.) PVT. LTD.
Post Bag 250, Madras 600 001, INDIA

ALVAN BLANCH DEV. CO. LTD.
Chetworth
Malmesbury, Wilts. SN16 9SG, U.K.



POWERED OIL-EXPELLERS

The oil expellers listed here consist of a tapered screw-auger which rotates in a perforated drum or slotted housing. The oil discharges through the slots or holes in the housing while the residue emerges from the annulus end of the screw.

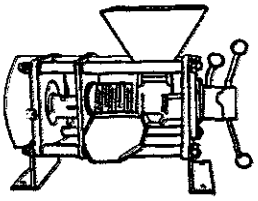
TYPE 52 OIL EXPELLER Constructed of cast iron and machined steel, the Type *52 expeller has a power requirement of* 3-5hp and an hourly output (seeds) of 30-50kg (illustrated).

TYPES M & H54 OIL EXPELLERS Slightly larger capacity machines with respective power requirements of 5hp and 8.5hp. They are suitable for oil extraction from most kinds of oil-bearing material.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

TABLE OIL EXPELLERS 4 models developed in India for the processing of oil-seeds normally carried out with 'Kohlus' and 'Ghanis', this simple and robust range of machines have a power requirement of 3-5hp and outputs of 30-55kg/h.

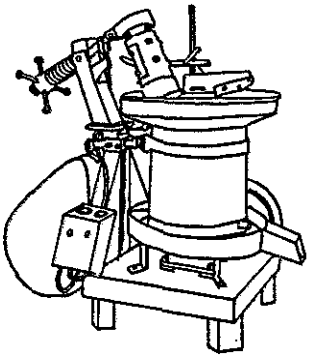
S.P. ENGINEERING CORPORATION
PB No 218, 79/7 Latouche Road
Kanpur 208 001
INDIA



THE MINI-40 OIL AND CAKE PRESS

The Mini 40 is a robust, small capacity screw press designed to convert sunflower and other seeds into oil and cattle cake. Powered by a 3hp (2.2kW) single phase motor capacities of up to 45kg/h are achieved.

SIMON-ROSEDOWN'S LTD.
Cannon Street, Hull HU2 OAD
U.K.



ROTARY OIL MILLS (GHANI)

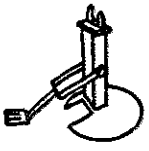
Unlike oil expellers, rotary mills operate on the principle of a stationary pestle working against a rotating mortar into which the oil seeds are fed.

PORTABLE POWER GHANI Weighing 530kg and powered by a 3-phase 2hp *electric motor, capacity is 12-15kg per* charge lasting about 75 minutes (illustrated).

KISAN KRISHI YANTRA UDYOG
64 Moti Bhawan, Collectorganj
Kanpur 208 001
INDIA

'RAJA' ROTARY OIL MILLS Milling efficiencies *range from 40 per cent* (groundnut) to 64 per cent (coconut). Power requirements are 5-7hp with a capacity of 1 charge (15kg) per 20-25 minutes.

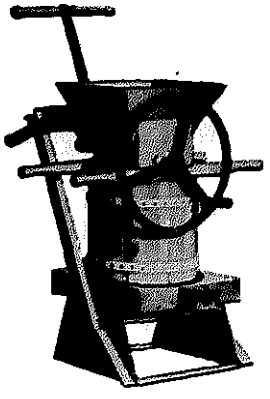
RAJAN UNIVERSAL EXPORTS (MFRS.) PVT. LTD.
Post Bag 250, Madras 600 001
INDIA



COCONUT CRACKER

Two blades are mounted on the stem of this cracker, and pierce the coconut. The pedal-operated divider then cracks the coconut into two pieces. This process is repeated and the husk quarters are then *struck off against the blades.* 100-200 coconuts can be cracked this way in an hour. This model is manufactured by Cecoco but is available through:

TECHNICAL ASSISTANCE (INTERNATIONAL)
Postfach 1224, Vosskuhlenweg 2
2072 Bargteheide
W. GERMANY



HAND-OPERATED FRUIT PRESSES AND CRUSHERS

Below are listed three manufacturers of different types of presses and fruit crushers.

'SIEGERIN' FRUIT AND BERRY PRESSES This lever-operated press when operated by one person achieves an hourly output of 25 litres of juice.

THE 'SIEGERIN' CRUSHERS These both grind and crush in one operation. Output for apples is 150kg/h. The illustration (left) shows the crusher mounted on top of the fruit press.

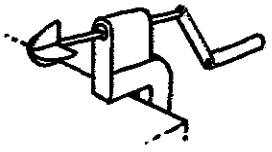
RAUCH LANDMASCHINENFABRIK GmbH
Postfach 1107, Sinzheim 7573
W. GERMANY

FRUIT AND BERRY PRESS & CRUSHER Two models available. One is a vertical, batch, screw press which compresses *fruit within a barrel. The second is a* horizontal axis crusher. The models are similar to those of Rauch.

COMPANHIA INDUSTRIAL DE FUNDIÇÃO
17 Rue de São João 27, 4000 Porto
PORTUGAL

PHOENIX FRUIT PRESSES Phoenix manufacture 3 models suitable for both soft fruits and apples.
'Cottager': a simple, heavily constructed table top fruit press. It is useful for soft fruits, but other fruits need to be sliced or ground beforehand.
'Harvester': a double tub cider mill; grinds and presses apples *simultaneously. Two people can produce* more than 300 litres of juice/day.
'Villager': a single tub cider press; the large tub holds about 0.03 cubic metres of ground apples which yields 3-10 litres of juice.

PHOENIX FOUNDRY
Box 68, Marcus, WA 99151
U.S.A.



GRATE-O-MATE COCONUT SCRAPER

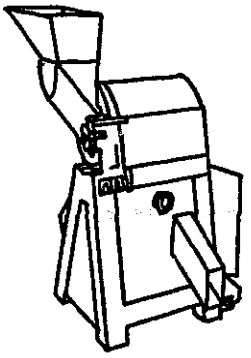
A hand-operated mill for scraping out *coconut flesh from the shell. It reduces* the time and energy traditionally associated with coconut scraping. Coconut halves are held with one hand against the 4-vaned scraper. The other hand turns the handle.

WOMEN'S REVOLUTIONARY SOCIALIST MOVEMENT HQ
44 Public Road, Kitty
Georgetown
GUYANA

'WOLF' GENERAL PURPOSE PULPER

Tigges manufacture a small range of general purpose pulpers for fruit processing.

GEBR. TIGGES GmbH & CO. KG
2 Sünninghausen
4740 Oelde
W. GERMANY



POWERED FRUIT CRUSHERS

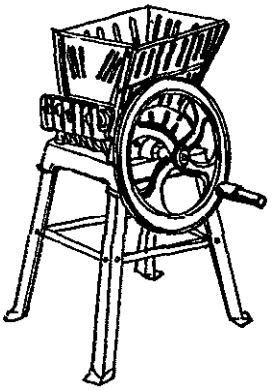
SZEGEDI SIEVING MACHINE This is an efficient sieving machine for apples, strawberries, gooseberries etc. The mesh of the sieves are 2-5mm. All parts coming into contact with the fruit are stainless steel. The processing rate of 4000kg/h is achieved with a 5.5kW motor.

SZEGEDI VAS-ES FEMIPART SZOVETKEZET
H-6724 Szeged, Katay u.23, HUNGARY

RAYLONS 'JUNIOR' PULPER Similar in *design to the above, this motor-operated* pulper is ideal for small commercial use.

SCREW TYPE JUICE EXTRACTOR Made as a complete unit, the extractor is driven by a 1hp 3-phase motor. Two sets of sieves are supplied. Capacity approx 1000 oranges or 800 lemons per hour.

RAYLONS METAL WORKS
Kondivitta Lane
J.B. Nagar Post Office
Andheri, Bombay 400 059, INDIA



ROLLER ROOT CUTTERS

These cutters have blades mounted on a horizontal cylinder. Various types are listed.

RENSON ROOT CUTTERS TYPE 'N' and TYPE 'B' These cast iron cutters have a capacity of up to 5 tonnes/h, and both can be adapted for a 2hp electric motor. The type 'B' is a smaller model, with 7 spiral blades and 8 pruning hooks, weighing 95kg. The type 'N' model (illustrated left) weighs 146kg, and has 8 toothed blades. It also has a sorting device consisting of four movable *paddles mounted on springs.*

RENSON ET CIE
BP 23, 59550 Landrecies
FRANCE

CECOCO ROOT CUTTER This is a small, hand-operated root cutter weighing 60kg. It has a capacity ranging from 500 to 700kg/h. It can also be adapted for an electric motor with a power requirement of 0.5hp.

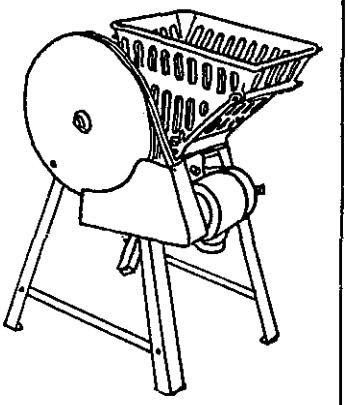
CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN

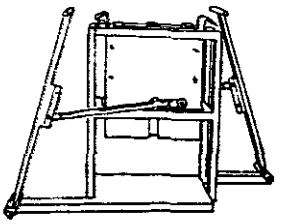
ROOT/CASSAVA CUTTER This is a double roller beet crumbler. It has easily exchangeable bearings. The funnel can be opened on both sides. Weight: 65kg. Output when manually operated 1500kg/h. Manufactured by Hofmann GmbH and available through:

TECHNICAL ASSISTANCE (INTERNATIONAL)
P.O. Box 1224
Vosskuhlenweg 2
2072 Bargtehelde
W. GERMANY

MOLOCH BEET CHOPPER A hand or power-operated chopper with a cylindrical blade drum. Also available is a model with a root cleaning cage (illustrated right).

GEBR. TIGGES GmbH & CO. KG
4740 Oelde, 2 Sünninghausen
W. GERMANY

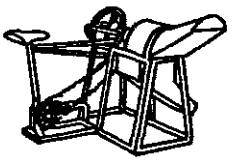




TWO-MAN CASSAVA GRATER

This manually-powered cassava grater can achieve a reasonable rotational speed and throughput. The lever action provides a greater power than hand-cranked models.

TRAAS METAAL B.V.
Groene Kruisstraat 3
4414 A L Waarde (2)
NETHERLANDS



PEDAL-OPERATED CASSAVA SLICER

This cassava slicer is fitted with a bicycle seat and a pedal mechanism. It is made of steel plate and weighs 80kg. The machine consists of one rotating, slicing blade. It has a capacity of up to 500kg/h.

P.T. KERTA LAKSANA
Jl Jenderal Sudirman 504
Bandung
INDONESIA

VERTICAL FOUR-BLADED ROOT CHOPPERS

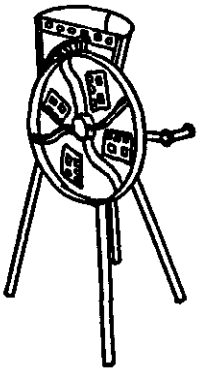
Below are listed two manufacturers of four-bladed rotary disc choppers.

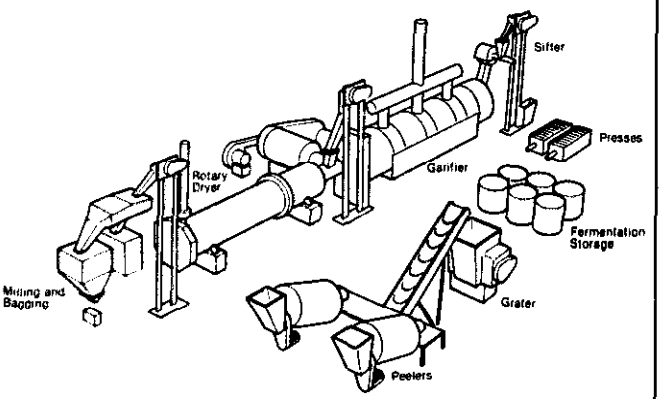
CASSAVA CHIPPER This is a rotary disc chipper with stainless steel, 65cm diameter rotor disc with four tapered, fluted cutting blades. Power required is 2hp to produce a rotor disc speed of 500rpm. Capacity is 2-3 tonnes/h.

FRANK WRIGHT FEEDS INT. LTD.
Misbourne House, Chiltern Hill
Chalfont St. Peter
Buckinghamshire SL9 9UH
U.K.

NARDI ROOT CUTTERS These (illustrated right) are manually operated *disc cutters with four knives. Three* models are available weighing 36, 40 and 48kg.

NARDI FRANCESCO & FIGLI
06017 Selci Lama, Perugi
ITALY





GARI PROCESSING PLANTS

The peeled tubers are grated, then stored for 3-5 days to ferment. The mash is then pressed, broken and fed into the garifier. The garifier is an indirectly heated rotating chamber with three independent temperature zones set to partially gelatinize the particles. The *gari* is then dried and milled into a course flour, which is bagged off. The N. D. Engineering plant is illustrated above.

N.D. ENGINEERING LTD.
Newell Dunford House
Portsmouth Road, Surbiton
Surrey KT6 5QF
U.K.

FABRICO GARI FRYING ASSEMBLY This system consists of a cassava grater, dough sifter mechanical press, solid fuel frying oven (garifier) with electrically-operated paddles and a movable stove with blower.

FABRICATION ENGINEERING CO. LTD.
P.O. Box 34, Ikeole-Uku
Bendel State
NIGERIA

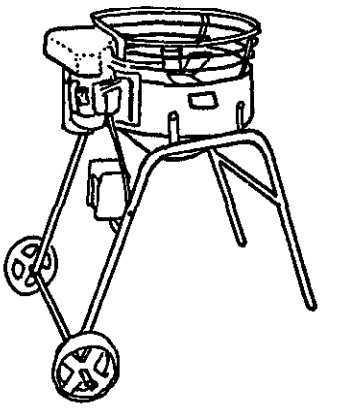
HORIZONTAL BLADE ROOT *CUTTERS*

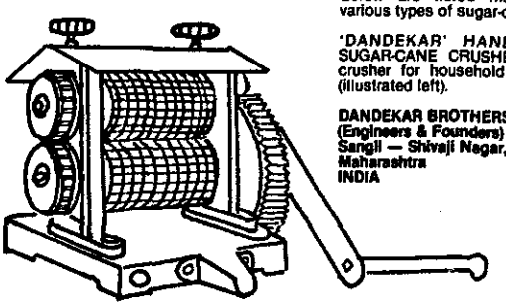
POWER TURNIP CUTTER The horizontal rim drive turnip cutter is produced by both Alvan Blanch and Elbar. It is a new design with 760mm diameter bowl to cope with large roots. The machine is practically free from maintenance costs; fitted with ball bearings throughout which ensures an easy silent drive.

It can be driven by a 1.5hp electric motor, or a 1.5hp engine. Finger piece *knives can be fitted in addition to the* slicing knives. Roots are cut to a uniform 19mm slice.

ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.

ELBAR AGRICULTURAL EQUIPMENT
Rattray, Blairgowrie PH10 7DN
U.K.





HAND-OPERATED SUGAR-CANE CRUSHERS

Below are listed manufacturers of various types of sugar-cane crushers.

'DANDEKAR' *HAND OPERATED* SUGAR-CANE CRUSHER A 2-cylinder crusher for household or factory use (illustrated left).

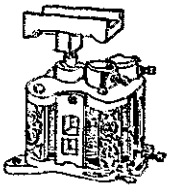
DANDEKAR BROTHERS
(Engineers & Founders)
Sangli — Shivaji Nagar, 416 416
Maharashtra
INDIA

SUGAR SQUEEZER TYPE B A hand-operated crusher which can be converted for motor drive. Capacity 115kg/h.

CECOCO
P.O. Box
Ibaraki City, Osaka 567
JAPAN

SUGAR-CANE MILLS Type TA-0 is a bench model made of cast iron with a wooden crank handle. Output ranges from 20 to 30 litres/h. Manufactured by Müller Irmãos, Brazil. Type TA-1 is a cast-iron crusher with 3 cylinders. It has a robust standing frame and can also be driven by a motor. Capacity ranges from 50 to 70 litres/h. Manufactured by *Pasiani, Brazil.* Both models available through:

TECHNICAL ASSISTANCE (INTERNATIONAL)
P.O. Box 1224
Vosskuhlenweg 2
2072 Bargtehelde
W. GERMANY



ANIMAL-POWERED SUGAR-CANE CRUSHERS

The crushing cylinders in these mills have a vertical axle which is connected by a bar to the animals that provide the power.

TWO-OXEN DRIVEN SUGAR-CANE CRUSHER Similar to those manufactured in India, but claims to be stronger. (Reliance also manufacture seven powered models, with a capacity from 50 to 1500kg/h and a power requirement of 8-40hp.)

RELIANCE ENGINEERING WORKS LTD.
P.O. Box 197, Kisumu
KENYA

BULLOCK-DRIVEN SUGAR-CANE CRUSHER This is a cast-iron crusher consisting of three rollers, with optional stand and a capacity of 200-230kg/h. Power attachment available for this model. Also Madurai produce larger powered 'Pushpa' and 'Madurai' models.

P.M. MADURAI MOODALIAR & SONS
Madurai Moodaliar Road
Post Box 7158
Bangalore 560 053
INDIA

3-ROLLER SUGAR-CANE CRUSHERS The 'Kumar' is a small, compact crusher which can be driven by one pair of animals. It has an output of 136-158kg/h. The 'Karamat' is made of cast-iron and has a capacity of 180-226kg/h. A power attachment is available. The 'Kamal' is a larger model with a capacity of 500-545kg/h.

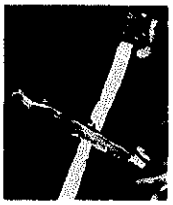
KIRLOSKAR BROTHERS LTD.
Udyog Bhavan, Tilak Road
Pune 411 002
INDIA

TRAPICHE VERTICAL 122 SUGAR-CANE MILL A light three-cylinder mill with a capacity of 4-6 tonnes/day. The cylinder pressure is adjustable by means of steel bolts (illustrated above).

PENAGOS HERMANOS & CIA. LTDA.
Calle 28, No 20-80
Apartado Correos 689
Bucaramanga
COLOMBIA

SUGAR-CANE MILL TYPE TA-AN1 Cast-iron one-animal powered crusher with adjustable cylinder pressure. Capacity is approx 200 litres/h. Manufactured by Müller Irmãos, Brazil and available from:

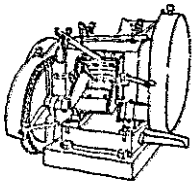
TECHNICAL ASSISTANCE (INTERNATIONAL)
P.O. Box 1224
Vosskuhlenweg 2
2072 Bargteheide
W. GERMANY



SUGAR-CANE STRIPPER

This is a hand tool consisting of a pair of tongs whose jaws close to form a square. The cane is drawn downwards through the jaws, stripping off the dry leaves. Output can reach up to 150kg per hour of sugar-cane.

INDIAN INST. OF SUGARCANE RESEARCH
Agri. Eng. Div.
Lucknow 226 002 U.P.
INDIA



POWERED SUGAR-CANE CRUSHERS

Powered horizontal-axis crushers produced by various manufacturers are listed below. The larger powered version, illustrated, is widely produced in India. Not illustrated are the smaller Brazilian models.

KOYNA-A AND SHARAT 2A POWER SUGAR-CANE CRUSHERS The Koyna-A has a power requirement of 4-5hp and a capacity of 365-455kg/h (illustrated left). The Sharat-2A is a larger, cast-iron crusher requiring 8-10hp, with a capacity of 550-675kg/h.

KIRLOSKAR BROTHERS LTD.
Udyog Bhavan, Tilak Road
Pune 411 002
INDIA

RAJA SUGAR-CANE CRUSHER AND MOBILE SUGAR-CANE CRUSHER The standard model is designed to be set into a concrete base. It has a capacity of 150-170kg/h and a power requirement of 5-7.5hp. The mobile model is made of cast iron and is mounted on a four-wheeled trolley. It has a capacity of 70-100kg/h and a power requirement of 1.95-3.4hp

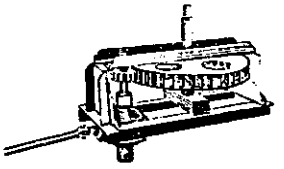
RAJAN UNIVERSAL EXPORTS (MFRS.) PVT. LTD.
Post Bag 250, Madras 600 001
INDIA

SUGAR-CANE CRUSHER MODEL N-30 Fixed to a frame, this smaller crusher produces up to 300 litres/h. It requires 2hp (electric motor), 5hp (petrol engine) or 3-4hp (diesel oil).

NOGUEIRA IRMÃOS SA
Rua XV de Novembro 781
P.O. Box 7
13970-1 Itapira, São Paulo
BRAZIL

TA-2 AND TA-70 CANE 'SQUEEZERS' TA-2 is a small (1hp) motor driven or manually operated crusher with a capacity of 80-100 litres/h. The TA-70 is a larger model with a power requirement of 3-4hp and a capacity of 400 litres/h. Both crushers are made of cast-iron and are mounted on a stand. Manufactured by Müller Irmãos and Pasiani of Brazil and available from:

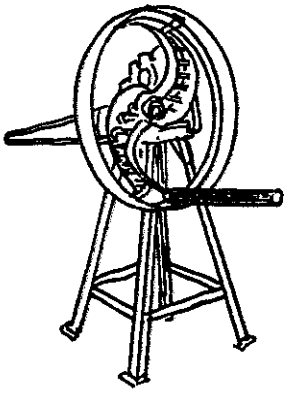
TECHNICAL ASSISTANCE (INTERNATIONAL)
P.O. Box 1224
Vosskuhlenweg 2
2072 Bargteheide
W. GERMANY



BULLOCK GEAR FOR ANIMAL-POWERED CROP PROCESSING

This mechanism converts the power of bullocks walking slowly round in circles into the high speed rotary motion of a shaft which can be used to drive stationary crop processing machines.

DANISHMAND & CO.
P-1 Street 6, Narwala Road
Mohammadpura, Faisalabad
PAKISTAN



HAND-OPERATED CHAFF CUTTERS

The following firms all manufacture a hand-operated forage cutter of this type. The cutter is mounted on a stand, and is operated by means of a handle on the flywheel so that the turning motion of the two blades within the wheel chops the forage as it is fed mechanically into the cutter. Length of cut can be altered between 7mm and 25mm. All the firms listed below produce cutters with two blades, with the exception of Lang Ferry and Renson, who manufacture a cutter of 3 and 4 blades respectively. Output may reach up to 800kg/h.

Maharashtra Agro's 'Krushi Udyog Chaffcutter' is illustrated left. The Alvan Blanch 'Simplex Chaff Cutter' is illustrated right.

MAHARASHTRA AGRO IND. DEV. CORPORATION LTD.
Rajan House, 3rd Floor
Near Century Bazar, Prabhadevi
Bombay 400 025
INDIA

DANDEKAR BROTHERS (Engineers & Founders)
Sangli — Shivaji Nagar 416416
Maharashtra, INDIA

PENAGOS HERMANOS & CIA. LTDA.
Calle 28 No. 20-80
Apartado Correos 689
Bucaramanga
COLOMBIA

KUMAON NURSERY
Ramnagar — 244715, Nainital, U.P.
INDIA

MODERN ENGINEERING COMPANY
1A Anna Street, Velandi Palayam
Coimbatore 641 025, Tamil Nadu
INDIA

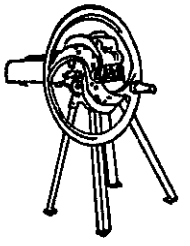
NARDI FRANCESCO & FIGLI
06017 Selci Lama, Perugia
ITALY

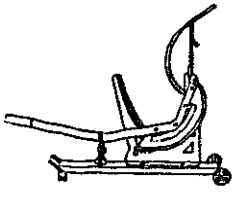
RENSON ET CIE
BP 23, 59550 Landrecies
FRANCE

ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SQ, U.K.

R. HUNT & CO. LTD.
Atlas Works, Earls Colne
Colchester, Essex CO6 2EP
U.K.

LANG FERRY & CIE
Brousseval (Hte-Marne)
52130 Wassy
FRANCE

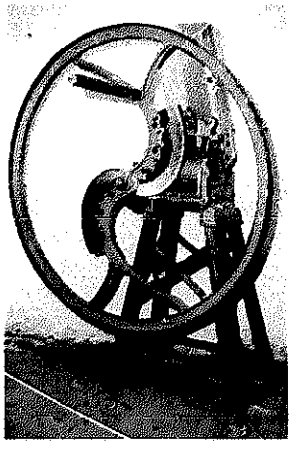


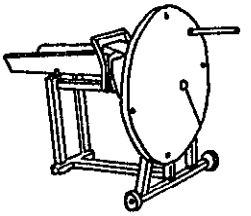


PS-1/66 STRAW CUTTER

This cutter is designed for use on small farms, for cutting straw and other green feed into pieces of any length. The hand-operated lever is attached at one end and has mounted on it the curved blade. Weight 25kg. Manufactured by Agromet KMRL, Rzuców and available through:

AGROMET MOTOIMPORT
Foreign Trade Enterprise
P.O. Box 990, Warsaw
POLAND



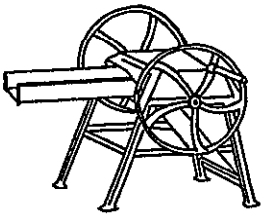


'AJANTA' 9M (illustrated left).

MOHAN SINGH HARBHAJAN SINGH
G.T. Road, Goraya 144 409 Pb.
INDIA

H-125/1 STRAW CHOPPER This type has an optional safety shield (illustrated above).

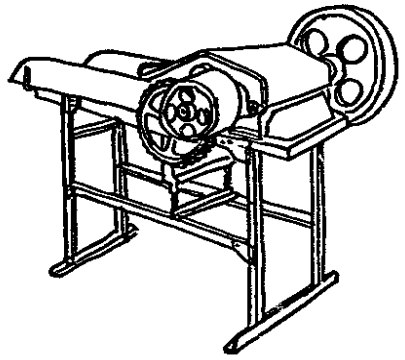
AGROMET MOTOIMPORT
Foreign Trade Enterprises
P.O. Box 990, Warsaw
POLAND



HAND-OPERATED DRUM FORAGE CUTTER H 127/1

Rollers crush the forage before it passes to the drum equipped with three blades. Output 120kg/h; can be adapted for electric motor drive. Weight 180kg. Manufactured by Państwowy Ośrodek Maszynowy Rudniki and available from:

AGROMET MOTOIMPORT
Foreign Trade Enterprise
P.O. Box 990, Warsaw
POLAND



POWERED DRUM TYPE FORAGE CUTTERS

P-10 CHAFFCUTTER This 4-bladed drum (illustrated above) is powered by a 2-3hp petrol engine or electric motor and has an output of up to 4000kg/h. The P-12 has 3 cutting blades attached to a rotating wheel.

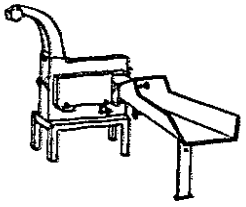
PENAGOS HERMANOS & CIA. LTDA.
Calle 28, No. 20-80
Apartado Correos 689
Bucaramanga
COLOMBIA

'JYOTI' 230 CHAFF CUTTER This model can cut dry or green fodder into pieces of about 1.5cm length. It has a 1hp electric motor and a capacity of 150-300kg/h.

JYOTI LTD.
Bombay Shopping Centre
R.C. Dutt Road
Vadodara 390 005
INDIA

CECOCO FORAGE CUTTERS Four models with a power requirement ranging from 0.5 to 10hp.

CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN



POWERED SILAGE CUTTERS

KOREAN CUTTERS Korea Trade produce a range of medium-sized cutters designed for preparing livestock feed. Power requirements range from 1-7hp. Capacities vary depending on the material to be chopped, but outputs can reach 4500kg/h for the larger models. The cutting length can be adjusted, and ranges from 16 to 150mm in length. Manufactured by Hyup Shin, Kum Sung, Hae Ryuk, Book Sung, Asia Ind. and Paek Cheon and available through:

KOREA TRADE PROMOTION CORPORATION
C.P.O. Box 1621, Seoul
KOREA

NOGUEIRA CUTTERS Nogueira produce two 'ensilage' cutters and three 'disintegrators' with a power requirement of 5-12.5hp. The ensilage cutters (illustrated above) have a capacity ranging from 2000 to 7000kg/h, while the disintegrators can produce up to 4000kg/h. Penha produce a similar range of forage cutters.

NOGUEIRA IRMÃOS SA
Rua XV de Novembro 781
P.O. Box 7
13970-1 Itapira, São Paulo
BRAZIL

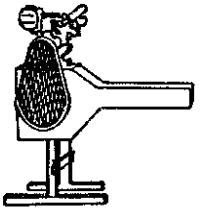
PENHA MAQ. AGRICOLAS, CIA
Av. Brazil 172A, C.P. 477
Ribeirão preto
BRAZIL

'RED FLAG' CHOPPER Capacity ranges from 1000kg/h for dry grass to up to 3000kg/h for silage or straw. Power requirement is 4kW. Manufactured by Zhang Zhen Farm Machinery Factory and available through:

CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing
CHINA

YAMAMOTO CUTTERS Yamamoto produce three types of cutter: Wheel, Cylinder (for straw and grass), and Branch, each with a range of models. Of these the 'wheel-type' cutters are designed for chopping forage for silage, and range from the small, light MB-3S, which has a capacity of 300-1000kg/h, to the TC-5S and LB2S models, which are medium sized with an output of 1000-3500kg/h, and up to the large heavy-duty D-20S and D25S, which produce up to 5000kg/h.

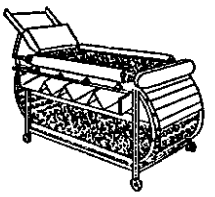
YAMAMOTO MFG. CO. LTD.
813-17 Tendo-ko, Tendo-shi
Yamagata ken 994
JAPAN



AB FIBRE RIBBONER

This machine is designed for the production of raw fibre from stem fibre crops such as Kenaf. It is fitted with a 3-beater drum and powered by a 5hp petrol engine.

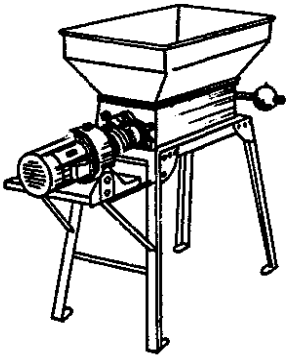
ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.



SHERPUR POTATO GRADER

The potatoes are fed in at one end, carried along by rubber spools, and sorted into as many grades as desired. Power requirement is 2hp and capacity can reach 2800kg/h with 3 or 4 persons operating the machine.

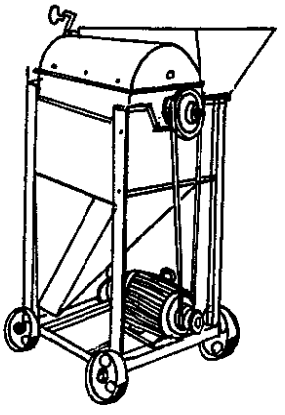
UNION FORGINGS
Focal Point
Sherpur, Ludhiana, Punjab
INDIA



DOUBLE-CYLINDERED TEA CUTTER

This machine is designed to cut tea to the desired size in the final stages of production. It has a cast-iron safety pawl and ratchet mechanism to prevent the machine from rotating in the wrong direction and damaging the blades and the cells. A deflector is fitted inside the hopper to eliminate 'greying' of the tea. The tea cutter is driven by a 0.5hp electric motor, and a belt drive with fast and loose pulleys is available. The cylinders are made from thin cast-iron discs held together by two long bolts which pass through them, and the cells are located on the periphery of the discs. Several sizes of cells are manufactured, giving a range of cutting sizes. A single-cylindered model is also available, as is a range of other tea processing machinery.

WALKER & SONS CO. LTD.
P.O. Box 166, Colombo
SRI LANKA

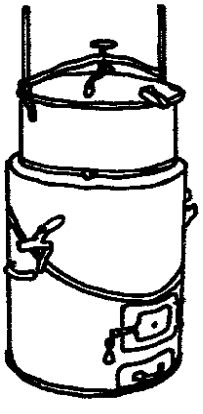


'JYOTI' MANGO STONE DECORTICATOR

This machine is capable of decorticating mango stones having a moisture content ranging from 3 to 75 per cent. The pericarps and mango kernels are separated in the decorticating chamber of the machine itself. It is equipped with an automatically opening and closing window, through which the pericarps left after decortication are ejected. The mango kernels are collected at the outlet chute.

Specifications:
- power requirement: 3hp electric motor
- capacity: 300-500kg mango stones
- length: 1060mm
- width: 950mm
- height: 1320mm
- weight: 140kg

JYOTI LTD.
Bombay Shopping Centre
R.C. Dutt Road, Vadodara 390 005
INDIA



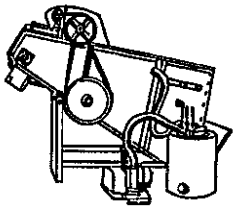
FARM STEAMERS H-020/0 & H-022/1

These two models steam potatoes for animal feed, and also boil water, use solid fuel, and can be operated inside or outside. The larger model has a boiling capacity of 100 litres and can steam 60kg of fresh potatoes, whereas the smaller model can boil 63 litres and can steam 48kg of potatoes.

Other specifications:	H-020/0	H-022/1
volume of water used (litres)	4	10
coal required for single lot (kg)	2.5	4.5
average steaming time (min)	40	45
burner grid area (sq.cm)	600	600

Manufactured by Agromet Dolzamet, Chojnow and available through:

AGROMET MOTO[illegible]PORT
Foreign Trade Enterprise
P.O. Box 589, Warsaw
POLAND



MOLASSES INJECTION EQUIPMENT

The molasses are heated in a 45-litre water tank by an immersion heater. They are mixed with air and injected through an atomizing fan jet. The line and jet are automatically cleared each time.

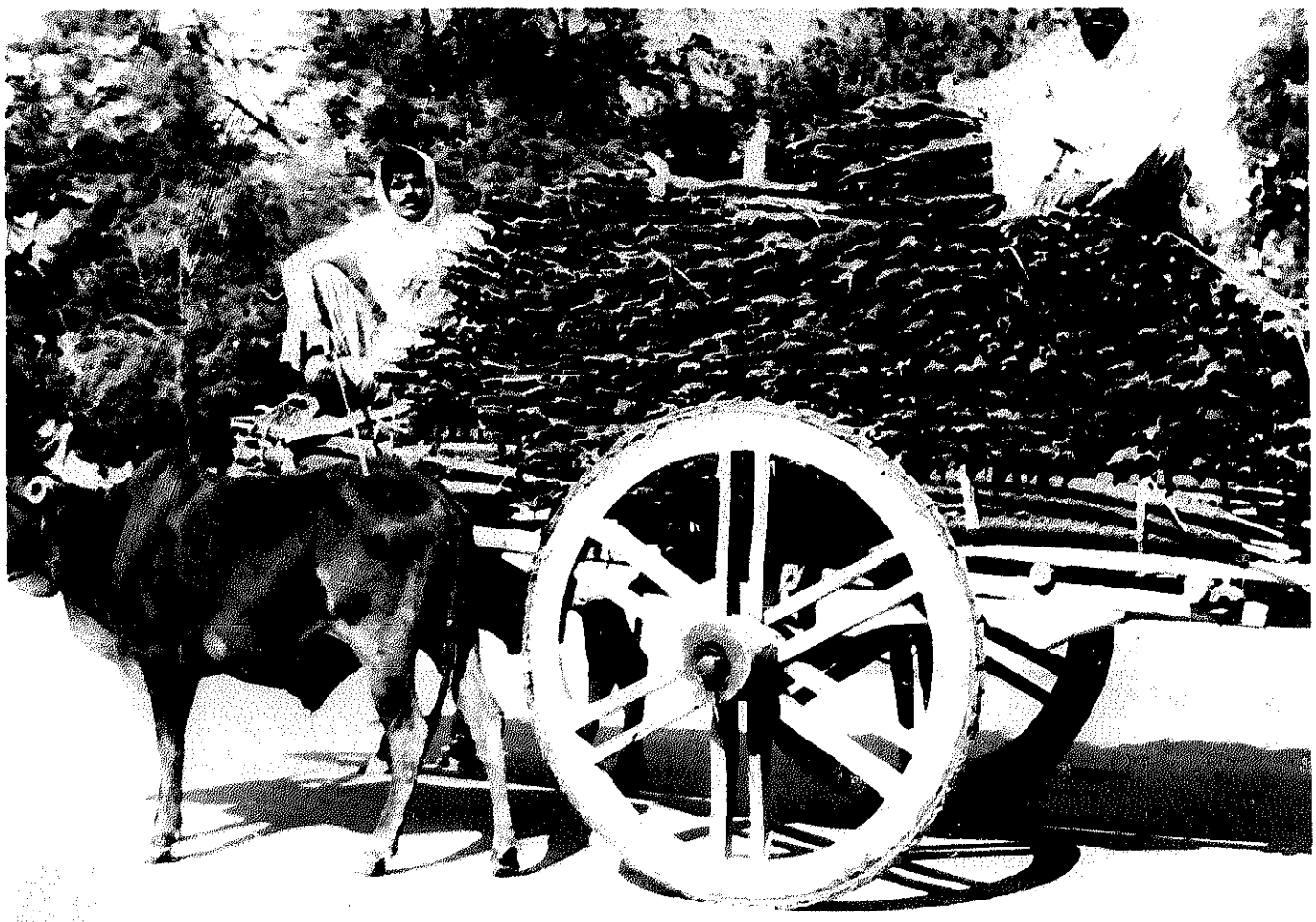
ALVAN BLANCH DEV. CO. LTD.
Chelworth
Malmesbury, Wilts. SN16 9SG
U.K.

FUFFLE

This simple piece of equipment stands on three legs. It is designed for mixing insecticide with maize, beans and so on, for storage purposes.

LEADING ENGINEERING
Bandari Road, Box 42131
Nairobi
KENYA

9. TRANSPORT AND MATERIALS HANDLING



Transport

A significant proportion of agricultural tasks involve moving equipment and materials from one place to another. Tools, fertilizer, seeds and produce must all be moved between field, store and market, which results in a wide variety of types and sizes of load to be moved over different distances and types of terrain. A range of different methods of transport and materials handling exists to carry out these tasks in different ways to suit different circumstances. Loads may be carried by hand or on the head, at one extreme, or a self-loading truck may be the most appropriate method at the other.

This section covers a very broad range of equipment as it is concerned with both transport and materials handling. In many respects these are different activities, but they are treated as one subject because they are very often complementary, in that materials handling is frequently concerned with loading and unloading vehicles or with moving goods over very short distances. The guidance given in this introduction is mainly concerned with transport, but much of it can also be applied to materials handling if interpreted with discretion.

In general, transport requirements fall into two categories:

- On-farm, for the movement of goods between field, store and household. On small farms this will include the collection of firewood and water for domestic purposes — work usually done by women. Loads are generally small (10-15 kg) and distances short (1-10 km). Routes are likely to consist of narrow paths and earth tracks, and the goods must also be moved over the fields themselves.
- Off-farm, for the movement of goods between farm and market. Loads are generally greater, and distances longer. Route conditions may be better, but this is not always the case.

Evidence from a number of surveys in different countries indicates that low-cost (low *capital* cost) methods of moving goods meet a much greater proportion of these transport requirements than do 'conventional' vehicles, such as tractors, pick-ups, trucks and buses. There exists a wide range of low-cost vehicles for moving farm goods which can be categorized as follows:

- Carrying aids for head-, shoulder- and back-loading.
- Wheelbarrows and handcarts.
- Pack animals and animal-drawn carts.
- Pedal-driven vehicles.
- Motor-cycles and converted motor-cycles.
- Trailers for bicycles and motor-cycles.
- Basic motorized vehicles.
- Dual-purpose agriculture/transport equipment.

All of these vehicles have different advantages and disadvantages in terms of load capacity, suitability for route conditions, running costs, speed, range and capital cost, which enable them to meet a broad spectrum of transport requirements. Further details and illustrations of the full range of these vehicles is contained in *Low-cost vehicles: options for moving people and goods* by G. Hathway (I.T. Publications, London 1985).

Only a limited range of these vehicles is included here because many of them are not widely available. Many low-cost forms of transport are used only in certain local areas, and remain unknown in other countries. Sometimes they are unknown even in other areas of the same country. Yet there seems to be no logical reason why many of these methods could not be used elsewhere, if their advantages were known and the equipment available. One obstacle to the widespread availability of some of such local equipment is that it is usually large relative to its value. Thus freight costs, which are determined by volume as well as weight, will be disproportionately high if the equipment is supplied from a distance. Only by ordering large quantities at one time can this problem be at least partially overcome. There remains potential in many countries for the local manufacture of many types of low-cost transport equipment on a small scale, and for the more important common components (such as bearings, axles and wheels) to be manufactured by specialist enterprises on a larger scale. There is also enormous potential for local manufacture of materials handling equipment such as shovels, forks, hoists and elevators.

Transport equipment

Wheelbarrows can carry small loads (up to 100 kg) for short distances (up to 1 km) over rough ground or on narrow paths. Pneumatic tyres are desirable, to reduce rolling resistance, and a heavy gauge steel load container will give long service.

Handcarts have two, three or four wheels which support the load directly, so minimizing the load on the operator's arms. Handcarts operated by one person can carry large loads (up to 300kg) over long distances (up to 10 km). Greater loads can be moved by using more than one person. Routes must be sufficiently wide and reasonably flat and smooth. Large diameter wheels, pneumatic tyres and roller bearings are desirable, as is a strong but lightweight structure. Some handcarts may also be used as a trailer with a bicycle or motor-cycle.

Special-purpose barrows are also available for moving specific loads, such as sacks or water containers.

Animal-drawn carts are constructed in a similar way to handcarts, but the size and capacity is determined by the type and number of animals to be used. Typically, a cart pulled by one donkey could carry up to 500 kg, or by one bullock up to 2,000 kg. Greater loads can be carried by using more than one animal. Route conditions and desirable features are the same as for handcarts. As well as carrying goods, animal carts can also carry people, and special purpose carts are available for specific tasks.

Trailers for single-axle tractors can carry up to 1,000 kg at up to 10 km/h, enabling an agricultural machine to be used for on- and off- farm transport as well. A wide track is required, but moderate hills and rough ground can be negotiated. Suspension and brakes are desirable to cope with the relatively high speed. People can be carried, as well as goods.

Engine-powered mono-rail transporters can be useful for carrying loads on steeply sloping land. As the railway is an expensive semi-permanent installation these systems can only be justified for moving substantial quantities over fixed routes in plantations of high-value perennial crops such as citrus fruit.

Materials handling equipment

Shovels and forks are used for handling materials such as grain, fodder and farmyard manure. The rate and distance of movement depends on the skill and strength of the user and also the quality of the tool. Poor quality tools will be unpleasant to use and will fail after a relatively short time, which will reduce output and necessitate frequent replacement.

Hoists enable heavy loads to be moved vertically for loading, unloading or storage. A good quality hoist will reduce the risk of accidents resulting from breakage.

Elevators incorporate a motorized conveyor belt to lift light loads quickly and continuously over short distances.

Advantages

There are a number of benefits which can result from using better methods of moving goods:

- less time or effort may be required to move a given amount of goods. This benefit will be felt by an individual as an increase in leisure time or a reduction in workload, although the saving may be used, of course, to do more productive work. An employer will benefit by an increase in productivity, enabling more useful work to be done by a given number of people;
- labour or other running costs may be reduced;
- transport bottlenecks may be relieved, which will reduce the delays and costs caused when transport is not available or is inadequate. Perishable goods can often be sold for a higher price if they reach the market sooner;
- the efficiency of other operations may be improved by making transport available at the right time and at the right place;
- other activities may be permitted to take place, such as the marketing of surplus produce for which transport was not previously available.

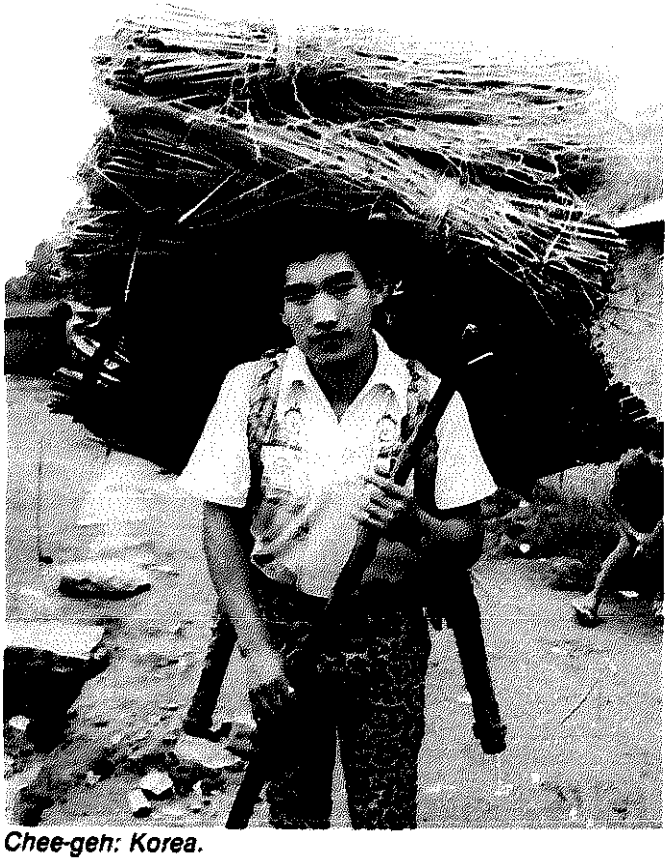
Alternatives

Before purchasing new equipment however, it should be considered whether the existing methods and equipment

Shoulder pole: Bangladesh.

could be used more effectively. Could trips be combined or carried out in a different order to minimize empty trips and reduce the total distance covered? Could loading/unloading time be reduced to prevent equipment standing idle? Could equipment and labour be hired temporarily to cover seasonal peaks in demand?

In addition, if new equipment is necessary, there is a wide range of alternatives to the inevitably limited range presented here. First, there are many small-scale suppliers who only advertise and promote themselves locally, and who are thus beyond the scope of this guide. They can be located by reading the local trade or popular press, or by speaking to people who already have the type of equipment sought. Secondly, some of the simpler devices mentioned here can be made by the user or by local craft-workers.



Chee-geh: Korea.

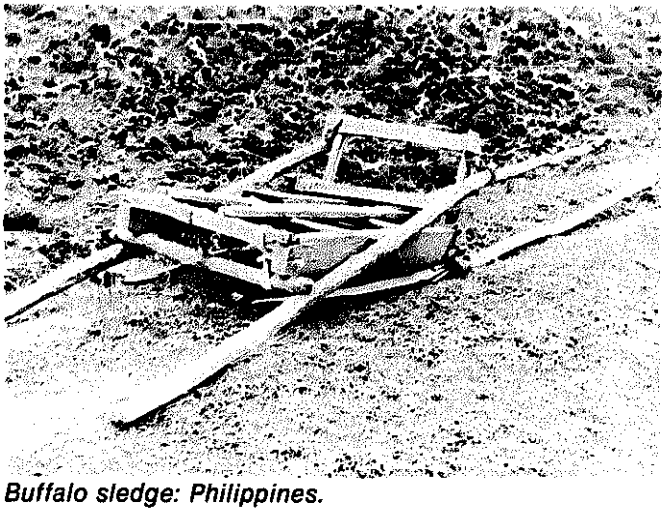
If goods are currently moved by direct head-loading or using head or shoulder straps, several simple aids could be used to improve efficiency. These include the shoulder pole and the chee-geh.

The *shoulder pole* is a length of split bamboo 120-200 cm long, 4-5 cm wide in the middle tapering to 3-4 cm at the ends. Loads are suspended directly, or in baskets, from the ends and the pole is carried on one shoulder. The most important advantage of this device is that it can be picked up and set down without assistance.

The *chee-geh* is a simple pack frame, carried by one person on the shoulders and back, which can also be picked up and set down without assistance. It is believed to be unique to Korea, where it is invaluable for moving loads on narrow paths and tracks which frequently cross ditches, and on steep and rough terrain.

If domesticated animals are available, *panniers* can be made, as baskets, pack frames or purpose-built containers, to enable them to carry loads over any ground which can be traversed on foot. Where there are earth tracks or generally flat ground, *sledges* can be used to increase further an animal's load-carrying ability.

General-purpose animal panniers: Ethiopia.



Buffalo sledge: Philippines.

Choosing Your Equipment: costs and returns

The following table shows indicative costs for the equipment presented in this section. No currency units are given as the costs are simply relative to others within

the table. It is not possible to estimate the cost of providing the necessary infrastructure as this varies so widely both within and between categories. Instead, a qualitative indication of requirements is given.

	Capital	*Running (Maintenance and repair)*	*Required Infra-structure*
Transport Equipment			
Wheelbarrow	30	5	—
Handcart	100	10	Wide track or flat ground
Animal carts	500 (exc. animal)	30 (exc. animal)	Wide track or flat ground
Trailers for single-axle tractors	500	30	Wide Track
Mono-rail transporters	20,000 (1,000 m length)	1,000 (exc. power)	—
Materials Handling Equipment			
Shovels and forks	10	1	—
Hoists	80	5	Support structure
Elevators	1,600	100 (exc. power)	Power supply

The cost of transportation is conventionally expressed as the cost per tonne kilometre, and is derived by dividing the total cost incurred in moving goods during a period of time (such as one year or three months) by the sum of the products of the individual loads moved and distances covered during the same period. In the simple case of moving produce from farm to market, the cost of transporting the load must be less than its increase in value for the trip to be worthwhile.

Costs incurred will include depreciation, maintenance and repairs, fuel, cost of capital (loan repayment or loss of interest), and the cost of the operator's labour (including overheads). Other costs such as tax and insurance may also be applicable. These costs must also be applied to the animal, where relevant, although if the animal is used for transport only part of the time, only an appropriate proportion of its total cost should be included. Similarly, only a proportion of total labour costs should be included where labour is used for other tasks as well.

To obtain the sum of the products of the individual loads moved and distances covered, or 'tonne km', the product of load moved and distance covered should be calculated for each trip carried out during the period for which costs are calculated. These trip totals are then added together to obtain the required result.

In making calculations of this type to estimate the costs of alternative methods of transport it is important to use the *actual* loads which will be carried, rather than the maximum loads which could be carried.

Example: Annual transport costs for rubber-tyred bullock cart, for first five years of life:

Cost of capital:	
Cart 3,000, financed by loan @ 15% per year, paid over 5 years	450
Bullocks 2,000, paid in cash. Loss of interest @ 8%. 50% of working time used for transport	80
Depreciation:	
Cart, over 5 years, zero resale value	600
Bullocks, zero depreciation. (Resale value = purchase price)	
Maintenance and repairs:	
Cart	150
Bullocks (inc. fodder) 2,000 × 50%	1,000
Labour:	
30% of working time used for transport	600
	2,880

Average daily load × distance (6 days per week):

January-March	0.6 tonne km/day	=	46.8 tonne km/quarter
April-June	0.8 tonne km/day	=	62.4 tonne km/quarter
July-Sept.	2.0 tonne km/day	=	156.0 tonne km/quarter
October-Dec.	0.5 tonne km/day	=	39.0 tonne km/quarter
			304.2 tonne km/year

Annual cost per tonne kilometre 2,880/304.2 = 9.14

Direct costs are not the only factor to be considered when choosing the most suitable type of equipment. Other considerations include intended use (or uses) of vehicle, technical capability, local availability and social acceptability.

In large or specialized organizations items of transport and materials handling equipment are often used for only one particular task. For most agricultural work, general purpose equipment is needed, so the first step in choosing an item is to decide the range of tasks which it must be able to perform. The next step is to determine the range of possible options by examining the following aspects:

- *Capability* Is the equipment capable of performing the required tasks? Is the load capacity high enough? Can it negotiate the route? Can it be operated fast enough?
- *Costs* Is sufficient cash available to purchase equipment or make loan repayments? Will the equipment result in sufficient cash savings or increased income to pay for itself in a short period of time?
- *Local availability* Is the equipment itself, and are the necessary animals, fuel or spare parts, available locally, both immediately and in the foreseeable future?
- *Social acceptability* Are there any social restrictions on people owning or using certain types of equipment or animals, or performing tasks in certain ways?

Having determined the range of possible options, a detailed analysis of all the economic factors will then reveal the most suitable choice (from an economic point of view). Where a choice exists between good and poor quality equipment it is important to acknowledge that although the initial cost of the good quality implement will be higher it will usually allow greater productivity and will need replacement less frequently.

Once the most suitable choice has been determined, an economic comparison should always be made with existing methods and with the expected benefits to determine whether the proposed innovation is worthwhile. Some of the benefits described earlier, such as a reduction in effort or increased leisure time, are not directly quantifiable in economic terms, but they must be regarded as having some 'value', in order to make this comparison.

Impact

Moving goods not only takes up a considerable proportion of time available for agricultural work, but it frequently involves debilitating human labour as well. Improvements in transport or material-handling methods will have an important social effect by enabling people to use their time and energy in other ways — either in productive work or by increasing their leisure time. Men tend to have greater access to improvements in transport than women because of their greater ease of access to credit and project inputs. Within households, women are usually unable to use a donkey, a cart or a bicycle owned by men. Thus, women have derived less benefit than men from improved transport devices and must continue in many parts of the world to carry very heavy loads on their heads and backs.

The use of complex and expensive vehicles and equipment will often create dependence on central or foreign suppliers, for fuel and spare parts as well as the original equipment. Much of the low-cost equipment described here however could be made by local

manufacturers without continuing dependence on imports and outside assistance. In the long term the use of this type of equipment would assist in developing local industry, thus creating productive employment opportunities in rural towns and saving valuable foreign exchange.

An often unexpected result of improving methods of goods transport is that personal mobility is increased as well. People will always travel farther and more often for social purposes when a better form of transport becomes available. This demand for transport is difficult to quantify, but it exists nevertheless. Its value is evidenced by the fact that some means of personal transport, be it an animal, a bicycle or a motor car, is so often a highly prized possession.

Single axle tractor and trailer carrying people: China.

The use of the most basic methods of moving goods, such as direct headloading or shifting loads by hand will often result in harmful effects, especially if used for long periods of time or with excessively heavy loads. These effects may be sudden, such as injuries incurred by falling or dropping loads accidentally, or they may develop over long periods in the form of chronic pain in various parts of the body. In either case, they result in a cost to society in terms of increased demands on health care facilities and reduced availability of productive labour time. All the equipment described here will reduce the effort required to move a given load, though it should always be remembered that if the new equipment is loaded to an excessive level there can still be harmful side effects.

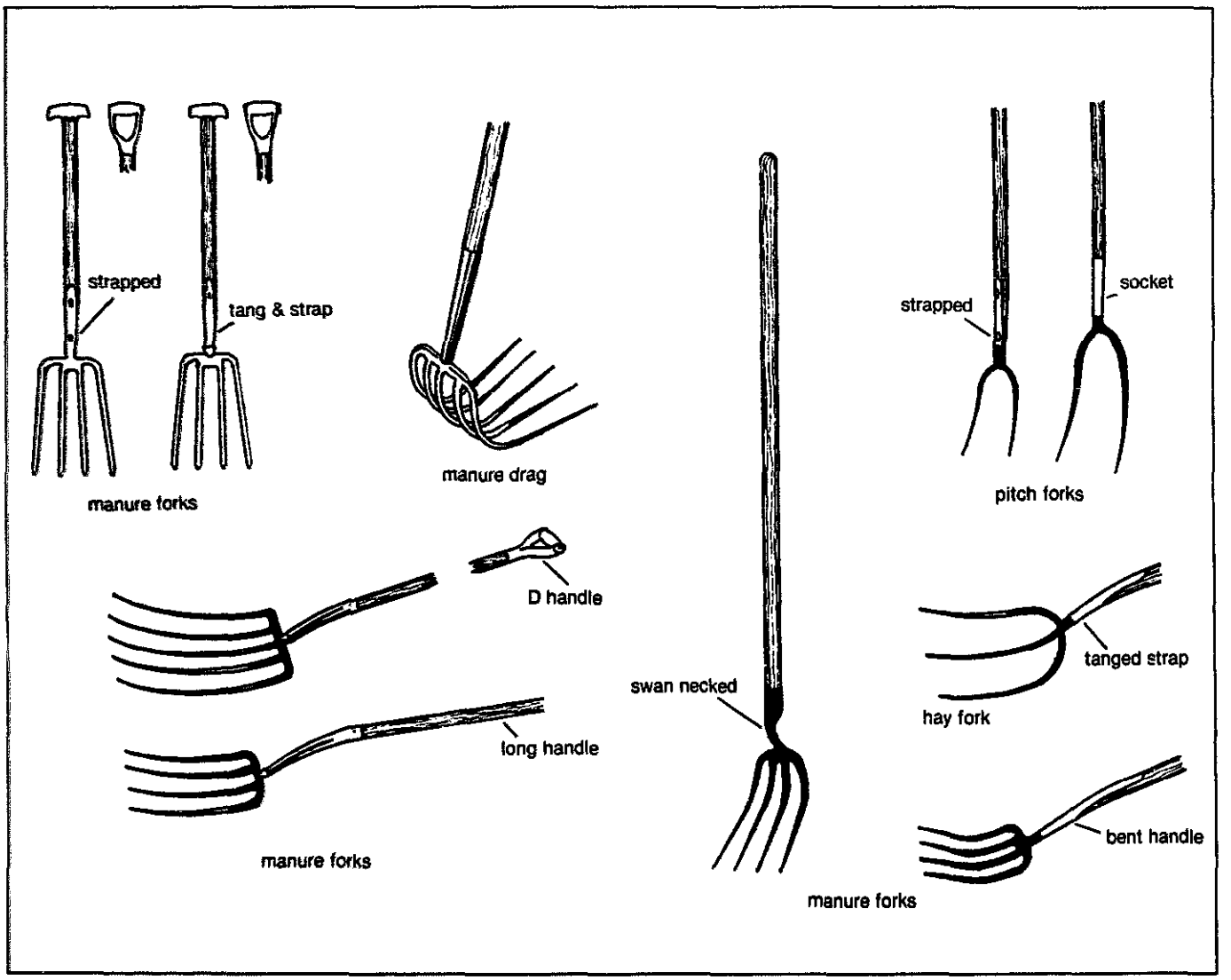
Motorized transport and material-handling equipment will require the same care in use as any other motorized machinery. In the case of vehicles, additional hazards caused by higher speeds and other traffic must also be recognized.

Special considerations

When new methods of moving goods are introduced operators must be trained in their use, and time must be allowed for them to become accustomed to the new method before maximum output will be achieved. This is particularly so for some of the very low-cost alternatives, such as carrying aids. Skills and strength in certain parts of the body must be acquired before these devices can be used effectively. The output of engine- and animal-powered devices is also dependent on the operator's care and skill in using and maintaining them.

Gordon Hathway
I.T. Transport Ltd

MANURE FORKS AND DRAGS



Handling loosely packed materials using suitably constructed forks (for lifting) and drags (for pulling) is the manual method most commonly used in European agriculture. The renewed worldwide interest in compost-making gives an increased importance to manure and hay forks: their use for carrying materials for building compost heaps would make feasible the dissemination of composting technologies among smallholder farmers who have a problem handling the required volumes of material. Several tonnes of compost are required to manure effectively one hectare of land.

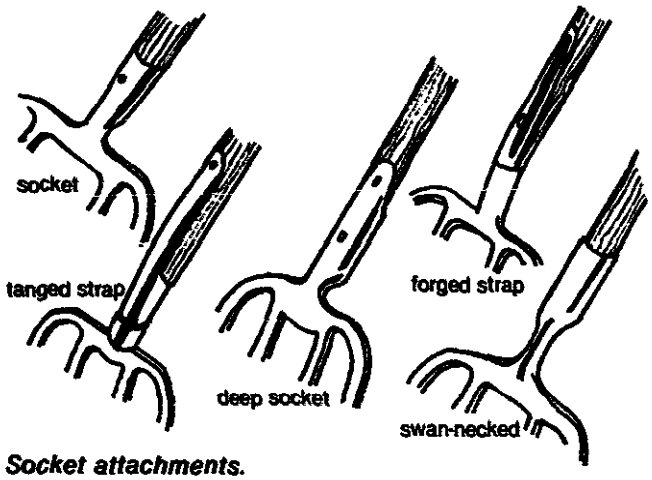
Oval section fork tines (prongs) penetrate into the mass of heaped material, pushing aside rather than cutting it. When a force is applied perpendicular to the tines, a large mass of inter-knit material can be moved. The number of tines needed for any particular task depends, to some extent, on the particle length of the material to be moved. For example, dung and urine-soaked straw cut up by the hooves of stall-fed animals will produce a crumbly material more easily moved by a fork with many tines; conversely hay, made from long grass, can be moved effectively using a two-tined pitchfork.

The shape of the handle and its attachment to the head are critical. By having a bent handle/shaft or a bent socket attachment the centre of gravity is moved, thus making it easier to handle heavy loads.

Traditional wooden tools made from tree branches are used for moving materials, but it is increasingly hard to find trees of the right shape. These tools, cut from wayside trees when needed, are often discarded after use. Properly designed steel forks will last a lifetime (though the wooden shafts may need replacing) if cleaned and lightly oiled after use, and have proved more efficient and effective.

The forces generated in the shaft are concentrated at its junction with the tines. They can be large if the mass of material to be lifted is heavy. Consequently much attention has been given to strengthening the socket.

Column 1 of the table which follows classifies the types of fork by the way in which the tool head (i.e. the fork or drag) is attached to the shaft. There are three basic forms of attachment that are commonly manufactured, although variations and combinations



Socket attachments.

may occur within and between these divisions. These forms are:

(a) *Socket attachments:* usually a split cylindrical collar into which the shaft is fitted ('open' socket). The shaft may then be secured by one or more screws, nails or rivets.

Variations on this are the solid socket which forms an unbroken collar into which the shaft is placed, and the swan-necked (bent) or sprung-socket.

(b) *Strapped attachments* formed from two tapered ferrule straps between which the shaft is fitted. The shaft is then secured into place by screws or rivets. This is the most durable of the attachments included here.

The Scottish and half-straps are variations on this type of attachment.

(c) *Tanged attachments:* a simple pin onto which the shaft is fitted. This attachment is often combined with a socket or strapped arrangement to ensure rigidity.

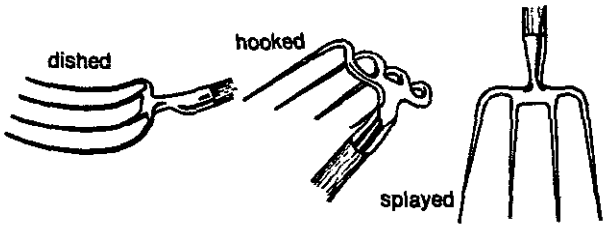
(d) *All-metal implements:* A shaft attachment may be strapped, although a welded fitting is more usual.

Column 2: number of tines. Occasionally the same model may be available with varying numbers of tines; for example, 4 or 5 tines. In this case, the column is entered as 4/5.

Column 3: tine shape. This column indicates the longitudinal shape of the tines.

There are 3 main shapes:

- *Straight (strt)* — the tines are straight, with only slight curvature. (Forks)
- *Dished (dish)* — the tines are generously curved. (Forks)
- *Hooked (hook)* — the tines are bent through 90 degrees. (Drags)



Shape of tines.

Column 4: Shape of head. Completing the general description of the tool head, this column indicates the way in which the tines are set relative to one another. Two forms are usual:

Splayed (splay) — where the tines are spread.

Parallel (pllel) — where the tines are parallel.

For example, a fork may have 4 curved tines which are splayed, while a similar model may have a parallel tine formation. Manure drag tines are always parallel.

Column 5: tine length (cm). Where more than one length is given (e.g. 22/26), each is taken to correspond to the respective number of tines given in Column 3.

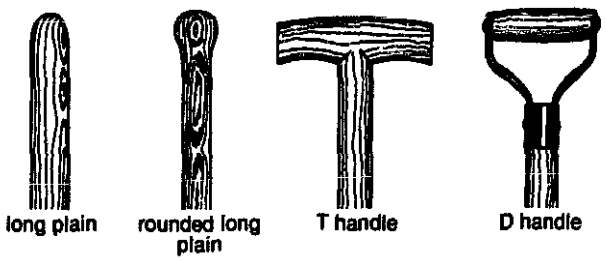
Column 6: shaft material. Where possible the type of wood or metal is specified, e.g. ash, birch, tubular steel, etc.

Column 7: handle type. This column indicates the available types of handle, which are classified into three categories:

T where the handle is a short cross-piece forming a T-shape at the top of the shaft;

D where the handle is a D-shaped grip. D-shaped handles may have one or two rivets which strengthen the cross-piece and the join with the shaft;

S where the handle is a (usually) longer, plain shaft, circular in cross-section, sometimes with a small or elongated (knob) at one end.



Handle types.

MANURE FORKS, HAY FORKS, BALING FORKS, PITCHFORKS, MANURE DRAGS

Manufacturer, Implement Type, Implement Name and Catalogue Number 1	*Number of Tines* 2	*Shape of Tines* 3	*Shape of Head* 4	*Tine Length (cm)* 5	*Shaft Material* 6	*Handle Type* 7
BULLDOG TOOLS, U.K.						
Clarington Forge						
Wigan						
Lancashire WN1 3DD						
MANURE FORKS						
Solid Socket — 5732/33, 5730/31	4/5	strt	splay		ash	T/D/S
Scottish strapped — 5734	4	strt	splay		ash	T/D
All-metal — 1748	4/5	strt	splay		metal	T/D/S
Strapped — 4711/12	4	strt	splay		ash	T/D/S
Tang & strap — 1711	4	strt	splay		ash	T/D/S
Tang & ferrule — 1758	4	strt	splay		ash	S
MANURE DRAGS						
Strapped — 4722	4	hook	pilel		ash	S
All-metal — 1102	4	hook	pilel		metal	S
HAY FORKS						
Strapped — 4732	2	dish	splay		ash	S
Tang & ferrule — 1732	2	dish	splay		ash	S
BALING FORKS						
Strapped — 4733/34	2	dish	splay		ash	S
COSMO INCORPORATED, JAPAN						
Towa Bldg 4th Floor						
10,4 — Chrome, Awaji-Machi						
Higashi-Ku, Osaka						
MANURE FORKS						
Socket — DPF4/5	4/5	dish	strt	32	wood	steel D
HAY FORKS						
Solid Socket — 411	3	dish	splay	30	wood	S
CUMBERLAND GENERAL STORE, U.S.A.						
Rt. 3 Box 479						
Crossville						
T.N. 38555						
MANURE FORKS						
Tapered socket — 7819/21/23	4/5/6	dish	pilel	30	ash	S/D
HAY FORKS						
Tapered socket — 7816	3	dish	pilel	30	ash	S
CALDWELLS LTD., U.K.						
Stockton Heath Forge						
Dallam Lane, Warrington						
MANURE FORKS						
3 rivet strapped — 606	5	dish	pilel	32	wood	T
MANURE DRAGS						
3 rivet strapped — 607	4	hook	pilel	24	wood	S
HAY FORKS						
Strapped — 608	2	dish	splay	25	wood	S
Tang & ferrule — 609	2	dish	splay	25	wood	S
ELKEM A/S, NORWAY						
Christiania Spigerverk						
P.O. Box 4224						
Torshov, Oslo 4						
MANURE FORKS						
Socket — 215/216	6	strt	pilel		wood	Metal D
MANURE DRAGS						
Socket — 405	5	hook	pilel		wood	S
FORGES DE LAVIEU S.A., FRANCE						
62 Bd. Waldeck-Rousseau						
B.P. 82						
42402 Saint-Chamond Cedex						
MANURE FORKS						
Swan-neck socket — 200	4	dish	pilel	30	ash	T/D/S
Socket — 201/202	3/4/5	dish	pilel	30	ash	T/D/S
Tang & strap — 205/206	4	dish	pilel	30	ash	T/D/S
Forked socket — 206	4	dish	pilel	30	ash	T/D/S
Tang & strap — 225	4/5/6	dish	pilel	32	ash	T/D/S
Socket — 226	4/5/6	dish	pilel	32	ash	T/D/S
MANURE DRAGS						
Socket — 711/712	3/4/5/6	hook	pilel	20	ash	S
Tang & strap — 715	4	hook	pilel	20	ash	S
Forked socket — 716	4/5	hook	pilel	20	ash	S
HAY FORKS						
Socket — 101	2/3	dish	splay	30		
Tang & strap — 105	2/3	dish	splay	22/25/28	ash	S/T
BALING FORKS						
Socket — 152	2	dish	pilel	20		
Tang & strap — 155	3	dish	pilel	23	ash	S/T
JENKS AND CATTELL LTD., U.K.						
Phoenix Works						
Neachells Lane, Wednesfield						
Wolverhampton WV11 3PU						
MANURE FORKS						
Socket — 901/902	4	dish	splay	32	metal	T/S
Strapped — 900	4	dish	splay	32	wood	T
KUMAR INDUSTRIES, INDIA						
Edathara 678611						
Palghat District						
Kerala						
MANURE FORKS						
Strapped — 128	4	dish	pilel	30	wood	D

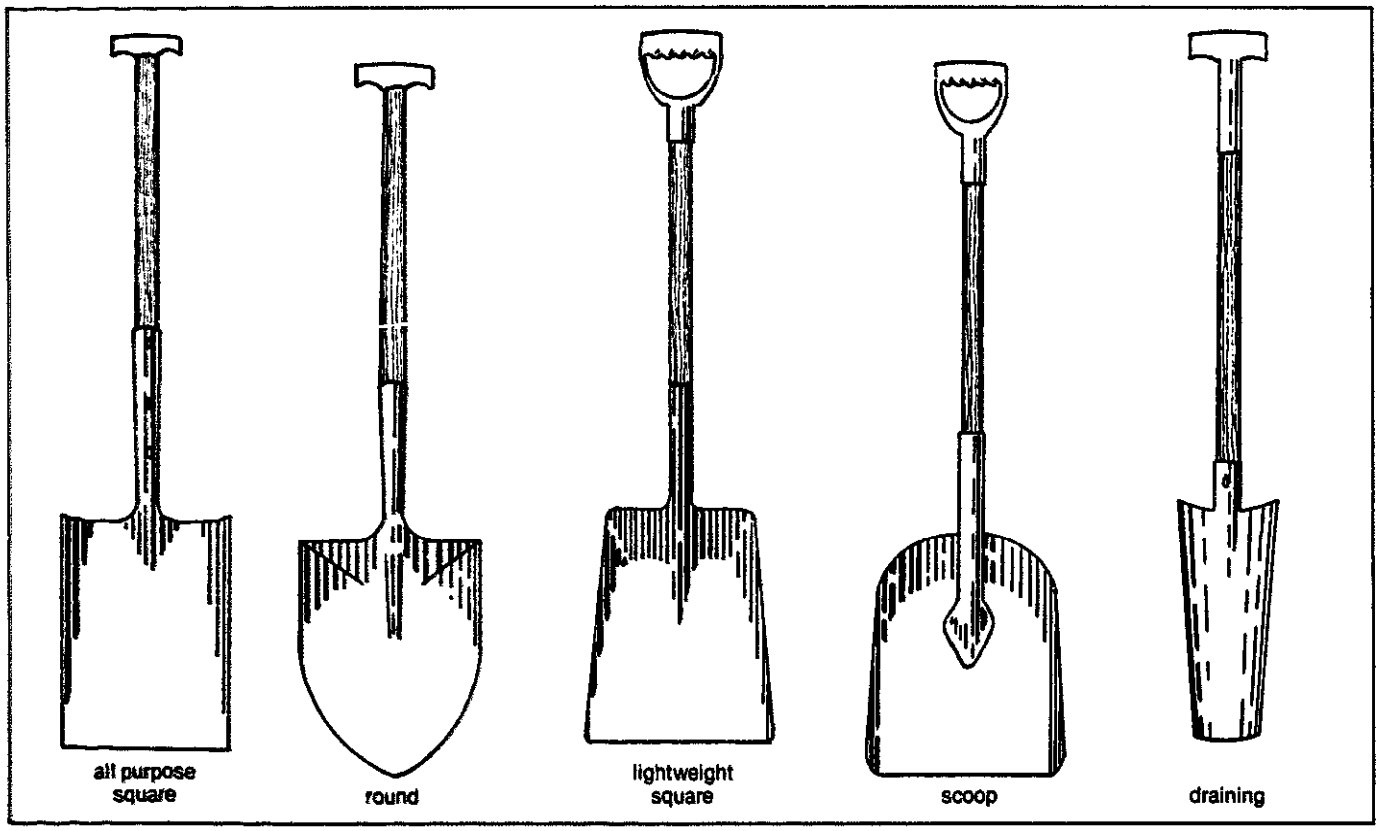
MANURE FORKS, HAY FORKS, BALING FORKS, PITCHFORKS, MANURE DRAGS

Manufacturer, Implement Type, Implement Name and Catalogue Number 1	*Number of Tines* 2	*Shape of Tines* 3	*Shape of Head* 4	*Tine Length (cm)* 5	*Shaft Material* 6	*Handle Type* 7
LEON CLÉMENT & CIE, FRANCE						
Corravillers						
70310 Faucogney (Haute-Saône)						
MANURE FORKS						
Socket —	4	dish	pilel	31	wood	S
Strapped —	4	dish	pilel	31	wood	S
MANURE DRAGS						
Socket —	4	hook	pilel	21	wood	S
HAY FORKS						
Socket —	3	dish	splay	29	wood	S
Strapped —	3	dish	splay	29	wood	S
LYSBRO FABRIKER A-S, DENMARK						
P.O. Box 219						
DK 8600 Silkeborg						
MANURE FORKS						
Socket — 241-243	4	dish	pilel	32	wood	T/D/S
Strapped — 254/255	4/5	dish	pilel	32/35	wood	T
Socket — 251/251T	5	dish	pilel	35	wood	T/D
Half-strapped — 273	5	dish	pilel	36	wood	D
MANURE DRAGS						
Socket	4	hook	pilel	25	wood	S
HAY & BALING FORKS						
Solid socket —	3	dish	pilel	32	wood	T
Socket — 226.5/231	2/3	dish	splay	30/32	wood	S
Socket (baling) — 228	2	dish	splay	2	wood	S
MANUFACTURE FRANÇAISE DE FOURCHES, FRANCE						
3 Rue de Lyon						
Terrenoire, B.P. 4						
42011 Saint-Etienne Cedex						
MANURE FORKS						
Socket — 201.3/4/5/6	3/4/5/6	dish	pilel	30	wood	S
Swan-neck — 200	4	dish	pilel	30	wood	S
Swan-neck — 210	4	dish	splay	30	wood	S
Half-strapped — 206.4	4	dish	pilel	30	wood	S
Strapped — 205.4	4	dish	pilel	30	wood	S
MANURE DRAGS						
Socket — 711/712	3/4/5/6	hook	pilel	20	wood	S
Sprung socket — 792	4	hook	pilel	20	wood	S
Half-strapped — 716	4	hook	pilel	20	wood	S
Strapped — 715	4	hook	pilel	20	wood	S
HAY FORKS						
Solid socket — 101.2/3	2/3	dish	splay	26/30	wood	S
Strapped — 105.2/3	2/3	dish	splay	22/30	wood	S
Tanged — 125.3	3	dish	splay	26/28	wood	S
BALING FORKS						
Solid socket — 152.2/3	2/3	dish	pilel	20/23	wood	S
Strapped — 155.3	3	dish	pilel	23	wood	S
PITCHFORKS						
Solid socket — 171.3	3	dish	splay	23	wood	S
Strapped — 175.3	3	dish	splay	30	wood	S
NORBERGS, SPAD & REDSKAPSFABRIKER AB., SWEDEN						
Vintergatan 7, 59132 Motala						
MANURE FORKS						
Strapped — 152J/160J	5/6	strt	splay	36	birch	D
Strapped — 162BJ	6	strt	splay	38	birch	D
MANURE DRAGS						
Socket — 146/156	4/5	hook	pilel	20/24	birch	S
SELF-SUFFICIENCY AND SMALLHOLDING SUPPLIES, U.K.						
The Old Palace, Priory Road						
Wells, Somerset BA5 1SY						
MANURE FORKS						
Socket — B75	4/5	strt	strt		wood	D
Strapped — B74	4/5	dish	splay		wood	S
MANURE DRAGS						
Strapped — B76	4	hook	pilel		wood	S
A. SPALDING AND SON LTD.						
Sadler Road						
Lincoln LN6 3XJ						
U.K.						
MANURE FORKS						
All-metal — 4001-3/6	4/5	strt	splay		metal	T/D/S
Strapped — 4004-6	4	strt	splay		wood	T/D/S
HAY FORKS						
Socket — 4014	2	dish	splay		wood	S
Strapped — 4011	2	dish	splay		wood	S
SPEAR AND JACKSON (TOOLS) LTD., U.K.						
St. Paul's Road, Wednesbury						
West Midlands WS10 9RA						
MANURE FORKS						
Solid socket — 1600	4	dish	pilel	33	wood	T/D/S
Scottish strapped — 1606	4	dish	splay	38	wood	T
Strapped — 1607	4	dish	splay	33	wood	T/D/S
All-metal — 1636	4	dish	splay	33	metal	T/D/S
Tang and ferrule — 1638	4	strt	pilel	32	wood	S

MANURE FORKS, HAY FORKS, BALING FORKS, PITCHFORKS, MANURE DRAGS

Manufacturer, Implement Type Implement Name and Catalogue Number 1	*Number of Tines* 2	*Shape of Tines* 3	*Shape of Head* 4	*Tine Length (cm)* 5	*Shaft Material* 6	*Handle Type* 7
MANURE DRAGS						
Socket — 1609	4	hook	pllel	26	wood	S
HAY AND BALING FORKS						
Solid socket (hay) — 1602	2	dish	pllel	24	wood	S
Solid socket (bale) — 1604	2	dish	pllel	19	wood	S
SYNDICAT DE L'OUTILLAGE, FRANCE AGRICOLE ET HORTICOLE 15 Rue Beaujon, 75008 Paris						
MANURE FORKS						
Socket —	4	dish	pllel		wood	S
MANURE DRAG						
Socket —	4	hook	pllel		wood	S
TROJAN PTY. LTD., AUSTRALIA 38 Raleigh Street Footscray, Victoria 3011						
MANURE FORKS						
Strapped — 109	4	dish	splay	21	wood	D/S
WÜRTT. GABELFABRIK, W. GERMANY Fr. Krauter KG Postfach 104 7067 Plüderhausen						
MANURE FORKS						
Socket —	3/4/5/6	dish	pllel	31/33/31/31		
Sprung socket —	4/5/6	dish	pllel	33/31/31		
Tanged —	3/4/5/6	dish	pllel	31/33/31/31		
Strapped —	3/4/5/6	dish	pllel	31/33/31/31	ash	T/D/S
MANURE DRAGS						
Socket —	3/4	hook	pllel	21		
WILHELM ABT GmbH & CO. KG, W. GERMANY Stuttgarter Straße 4-8 Postfach 1120 7060 Schorndorf/Württ.						
MANURE FORKS						
Strapped — 1015, 1165, 1512, 1602	3/4/5/6	dish	pllel	31/33/31/31	wood/metal	S
Socket — 0110	4	dish	pllel	31	wood/metal	S/T
Socket — 1010, 1160, 1510	3/4/5	dish	pllel	31/33/31	wood/metal	S/T
Sprung socket — 1161, 1511	4/5	dish	pllel	33/31	wood/metal	S/T
Tanged — 1012, 1162, 1512, 1602	3/4/5/6	dish	pllel	31/33/31/31	wood/metal	S/T
MANURE DRAGS						
Socket — 4430, 4440	3/4	hook	pllel	21	wood/metal	S/T
Tanged — 4435, 4445	3/4	hook	pllel	21	wood/metal	S/T
HAY FORKS						
Solid socket — 2714, 3214	2/3	dish	splay	28	wood	S
Strapped — 3304	3	dish	splay	31	wood	S
Sprung socket — 3521, 41, 51, 61	3/4	dish	splay	30/33/37/42	wood	S
Tanged (straight shaft) — 2712, 3012	2/3	dish	splay	28	wood	S
Tanged (curved shaft) — 3582, 3402	3/4	dish	splay	37	wood	S
Strapped — 3515, 3545	3	dish	splay	28/33	ash	S
(*Note:* the above is a selection of a wider range available from ABT)						
BALING FORKS						
Solid socket — 2866, 3266	2/3	dish	pllel	23	ash	S
CEAF, ITALY S.N.C. Filli Siletti 24034 Cisano, Bergamasco						
MANURE FORKS						
Socket — 6470	4	dish	pllel		wood	S
HAY FORKS						
Socket — 6460	3	dish	pllel		wood	S
KELLER MFG CO. INC., U.S.A. 4324-36 Fyler Avenue St. Louis, M15 63116 U.S.A.						
MANURE FORKS						
Strapped —	5	dish	pllel		wood	S

SHOVELS



The shovel, which has been employed since the earliest times in both agricultural and construction activities, is a tool used to move loose or unconsolidated materials short distances. It differs in form and function from the spade (see Section 1, Seedbed Preparation) which is essentially a digging instrument.

The diversity of tasks (and, to a certain extent, conditions) to which the shovel has been applied is reflected in the correspondingly wide range of shovel types developed over the years. As an example, the two very different tasks of grain transport and earth clearance serve to demonstrate how shovel forms have evolved to suit quite specific functions.

In this case the most obvious difference seen is between the shapes of the shovel heads. On the one hand, the earth-moving shovel is relatively small and rounded or pointed. Such a shape is suited to the penetration and dislodgement of heavy, cohesive materials. On the other hand, the grain shovel, which is used for the handling of a light and incoherent material, is large and broad-mouthed, being better suited to the movement of large quantities at a time, rather than the heavier duty work of earth clearance. Note also that the grain shovel is equipped with a raised edge that increases the capacity of the implement. An earth-moving shovel has no need for this kind of addition, since earth is considerably more coherent than grain.

Further, the nature of its task means that the grain shovel can be lighter and less robust than the shovel used for the movement of earth: lighter, thinner metal is used for making the grain shovel head.

This brief example shows how two very different types of shovel can be described in terms of their function, and accounts in part for the diversity of shovels used throughout the world. The following table offers a small range of shovels most useful to agricultural activities, and lists their main characteristics (see page 176).

Information given is:

Column 1: Manufacturer's name and country.

Columns 2-6: Five broad classes of shovel most useful in agriculture. Availability is indicated by large dots in the respective column.

Column 2: Round-mouthed shovels; usually heavy-duty implements.

Column 3: Square-mouthed shovels; usually lightly-made for tasks such as grain handling.

Column 4: Square-mouthed shovels; all-purpose implements.

Column 5: Scoops; very large-capacity, light-duty shovels.

Column 6: Tapered shovels; usually heavy-duty for more specialist work such as trenching.

Column 7: Shovel head width in centimetres.

Column 8: Shovel head length in centimetres.

Column 9: Socket type — here 3 types are distinguished (see *Manure Forks*).

a. Solid socket: because, as a general rule, shovels are not stressed to the same extent as digging tools or manure forks; this is the most widely used socket in shovel manufacture.
b. Strapped socket.
c. Open socket.

Column 10: Handle type:

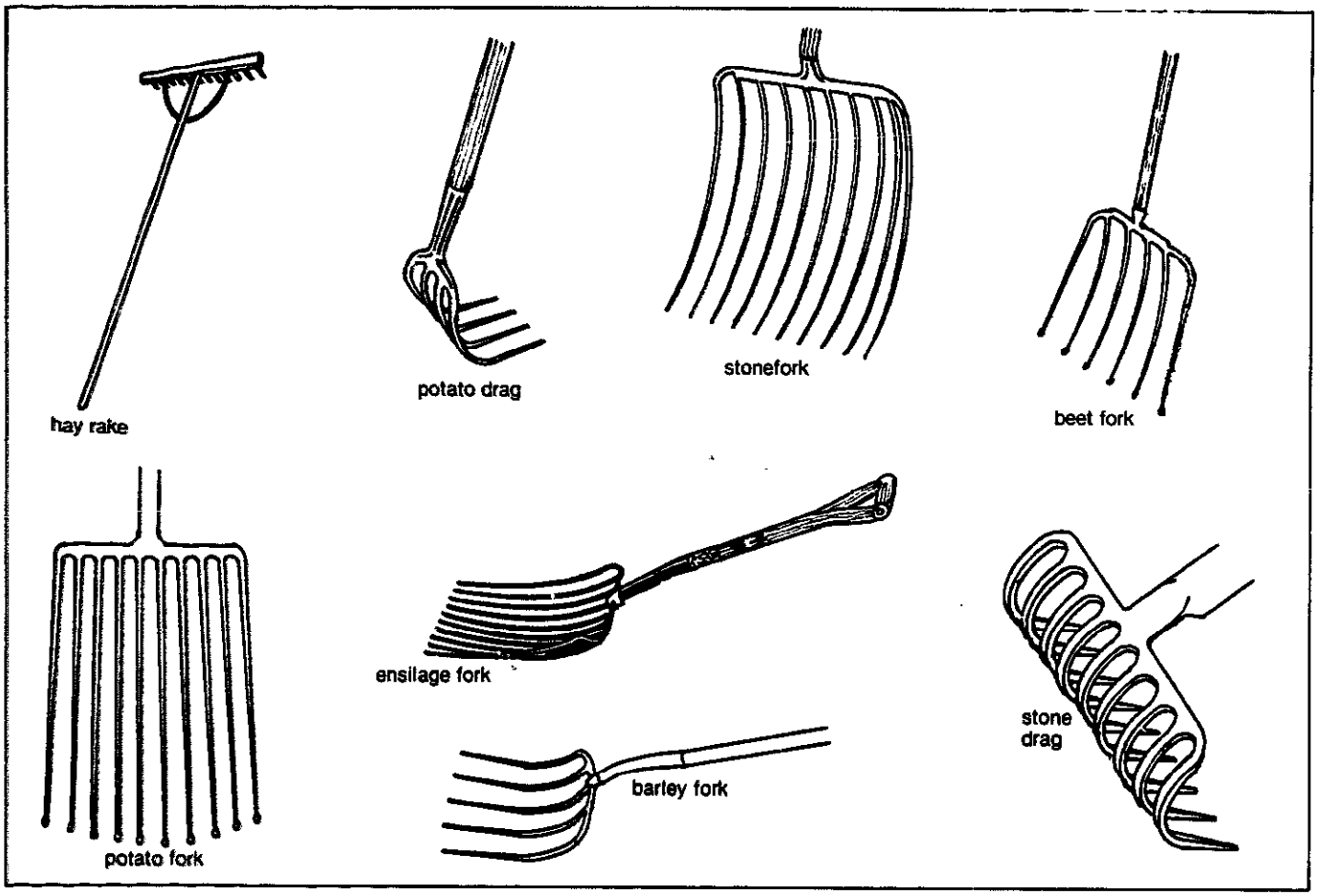
a. T — T-shaped.
b. D — D-shaped.
c. S — straight or 'Long-knob'.

Column 11: Additional information such as shovel metal type, function, etc.

Manufacturer						Head Width (cm)	Head Length (cm)	Socket Type	Handle Type	Other Details
Column No. 1	2	3	4	5	6	7	8	9	10	11
WILHELM AST GmbH & CO. KG W. GERMANY		●				38.0	38.0	solid	T/D/S	Alumin.
		●				38.0	38.0	solid	T/D/S	Steel edge
		●				32.5	34.0	solid	T/D/S	Alumin.
		●				32.5	34.0	solid	T/D/S	Steel edge
		●				23.0	31.0	solid	T	Alumin.
ELKEM A/S NORWAY		●				—	—	solid	D	Ballast
				●		—	—	solid	S	Concrete
				●		—	—	solid	D	Coal
		●				—	—	solid	D	Ballast
AÇOTUPY IND. MET. LTDA. BRAZIL	●					25.2	31.0	—	S	
			●			23.0	32.0	—	S	
BORAL CYCLONE LTD. AUSTRALIA	●					24.5	30	Solid	S	Tread
	●					29.0	31	Solid	D/S	Tread
			●			26.0	31.5	Solid	D/S	
			●			19.0	26.0	Solid	S	Tread
					●	11.5	29.0	Solid	S	Tread
BULLDOG TOOLS U.K.	●	●	●			—	—	Strap	T/D/S	Steel
	●	●	●			—	—	Solid	T/D	Steel
	●	●	●			—	—	Metal	T/D	Steel
			●			—	—	Strap	T/D	Steel
				●		—	—	Open	S	Alloy
BURGON AND BALL LTD. U.K.	●					25.5	32.0	Solid	T	Steel
		●				33.0	39.5	Open	T	Alloy
			●			25.5	32.0	Open	T/D	Steel
			●			25.5	32.0	Solid	T/D	Steel
		●				25.5	32.0	Solid	T	Steel
CALDWELLS LTD. U.K.	●	●	●			25.0	32.0	Strap	T/D	
	●	●	●			25.0	32.0	Solid	T/D	
					●	15.0	40	Solid	T	
	●					29.0	33.5	Open	T	
		●				30.0	36.0	Open	T	
LÉON CLÉMENT & CIE FRANCE		●				27.0	33.0	Solid	—	
			●			16.0	24.0	Solid	—	
			●			18.0	32.0	Solid	—	
			●			23.0	27.0	Solid	—	
			●			27.0	31.0	Solid	—	
FERFOR PORTUGAL	●					23.0	30.0	Solid	D/S	Tread
						24.5	29.5	Solid	D/S	Tread
E. GHERARDI E. HIJOS S.A. ARGENTINA	●					22.5	30.0	Solid	T/D/S	
		●				24.5	30.0	Solid	T/D/S	
		●				27.5	40.0	Solid	T/D	
			●			14.7	30.0	Solid	T/D	
			●			13.5	40.0	Solid	T/D	
KENYA ENG. INDUSTRIES KENYA	●						31.5	Solid	T/D	
		●					31.0	Solid	D	
		●					31.0	Solid	D	
HERRAGRO COLOMBIA	●					22.0	32.0	Solid		
			●			25.0	32.0	Solid		
				●		20.0	47.0	Solid		

Manufacturer						Head Width (cm)	Head Length (cm)	Socket Type	Handle Type	Other Details
Column No. 1	2	3	4	5	6	7	8	9	10	11
IDEALSPATEN BREDT & CO. KG. W. GERMANY	●					17.0	29.0	Solid	T/S	
		●				30.0	36.5	Solid	D	
		●				31.5	43.0	Solid	D	
				●		25.0	31.0	Solid	D	
CEAF ITALY	●					27.0	30.0	Solid	T/S	
	●					—	—	Solid	D	
	●					—	—	Solid	D	
KOREA TRADE PROMOTION CORPORATION	●	●	●			—	—	Solid	D/S	
	●	●	●			—	—	Solid	D/S	
	●	●	●			—	—	Solid	D/S	
	●					—	—	Solid	D/S	
	●	●	●			—	—	Solid	S/D	
MOHINDER & CO. INDIA	●							Solid	D	
		●						Solid	D	
COSMO INCORPORATED JAPAN	●					22.0	30.0	Solid	Y	All steel
	●					19.0	26.5	Solid	S	
			●			24.0	29.0	Solid	Y	
				●		27.0	36.0	Solid	Y	
		●				25.0	29.5	Solid	Y	
FORGES DE LAVIEU S.A. FRANCE		●						Solid	S/D	
			●					Solid	S/D	
LYSBRO FABRIKER A-S DENMARK				●		23.5	32.5	Strap	T	
SYNDICAT DE L'OUTILLAGE FRANCE	●					—	—	Solid	S	
			●			—	—	Solid	S	Coal
				●		—	—	Solid	S	Alloy
TRAMONTINA SA BRAZIL	●					25.0	27.0	Solid	—	Steel
	●					27.0	27.0	Swan	—	Steel
	●					28.0	33.0	Solid	—	Steel
		●				27.0	29.0	Solid	—	Steel
			●			27.0	33.0	Solid	D	Steel
TROJAN PTY. LTD. AUSTRALIA	●					27.5	32.5	Solid	S	
					●	13.5	29.0	Solid	S	Tread
		●				26.5	32.5	Solid	D	
			●			18.5	27.5	Solid	S	Tread
				●		—	—	Solid	D	Scoop
TROPIC CAMEROON	●					—	—	Solid	Y	
	●						—	Solid	—	
	●					—	—	Solid	—	
	●					—	—	Solid	—	
					●	—	—	Solid	—	
ZANA ZA KILIMO LTD. TANZANIA	●					—	—	Solid	D	
		●				—	—	Solid	D	
KELLER MFG. CO. INC. U.S.A.	●					—	—	Solid	S	
ZINCK'S FABRIKER A/S DENMARK		●								Tread

MISCELLANEOUS MATERIAL-HANDLING TOOLS



In addition to the manure and hay forks and drags already described, there are a number of other specialist material-handling tools available to the farmer. These are listed below by manufacturer:

WILHELM ABT GmbH & CO. KG
Stuttgarter Straße 4-8
Postfach 1120
7060 Schorndorf/Württ.
W. GERMANY
- Hay rakes
- Stone forks
- Potato forks
- Grain forks

ELKEM A/S CHRISTIANA SPIGERVERK
P.O. Box 4224, Torshov
Oslo 4, NORWAY
- Hay rakes
- Potato drags
- Potato forks
- Stone forks

CUMBERLAND GENERAL STORE
Rt. 3, Box 479
Crossville, T.M. 38555
U.S.A.
- Ensilage forks
- Grain forks
- Potato drags

BULLDOG TOOLS
Clarington Forge
Wigan
Lancashire WN1 3DD
U.K.
- Hay rakes
- Loading forks
- Stone forks

LÉON CLÉMENT & CIE
Corravillers
70310 Faucogney (Haute-Saône)
FRANCE
- Potato drags
- Stone forks

JENKS AND CATTELL LTD.
Phoenix Works, Neachells Lane
Wednesfield
Wolverhampton WV11 3PU
U.K.
- Hay rakes

CALDWELLS LTD.
Stockton Heath Forge
Dallam Lane, Warrington
U.K.
- Stone forks

MANUFACTURE FRANÇAISE DE FOURCHES
3 rue de Lyon
Terrenoire, B.P.4
42011 Saint-Etienne Cedex
FRANCE
- Beef fork
- Potato fork
- Stone forks
- Stone drags

FORGES DE LAVIEU S.A.
62 Bd. Waldeck-Rousseau
B.P. 82
52402 Saint-Chamond Cédex
FRANCE
- Reaping fork
- Beet forks
- Stone forks
- Stone drags
- Loading forks

LYSBRO FABRIKER A-S
P.O. Box 219
DK 8600 Silkeborg
DENMARK
- Beet forks
- Stone forks
- Potato forks

CEAF
S.N.C. F.lli Siletti
24034 Cisano
Bergamasco
ITALY
- Potato forks
- Stone forks

A. SPALDING AND SON LTD.
Sadler Road
Lincoln LN6 3XJ
U.K.
- Beet forks
- Potato forks

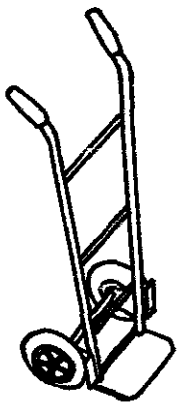
COSMO INCORPORATED
Towa Bldg 4th Floor
10-4 — Chome, Awaji-Machi
Higashi-Ku, Osaka
JAPAN
- Potato drag

TROJAN PTY. LTD.
38 Raleigh Street
Footscray, Victoria 3011
AUSTRALIA
- Hay rakes

KUMAR INDUSTRIES
Edathara 678611
Palghat District, Kerala
INDIA
- Stone forks

WÜRTT. GABELFABRIK
Fr. Krauter KG
Postfach 104
7067 Plüderhausen
W. GERMANY
- Hay rakes

SPEAR AND JACKSON (TOOLS) LTD.
St. Paul's Road, Wednesbury
West Midlands, WS10 9RA
U.K.
- Hay rakes
- Potato forks
- Beet forks



HAND-PUSHED SACK AND CASE TRUCKS

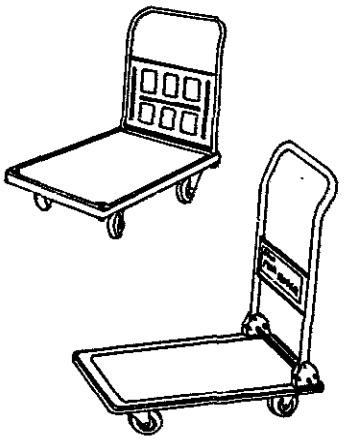
Hand-pushed trucks can be used in a variety of situations for the transport of sacks or cases. They have a rigid frame and foot-iron in which the load is carried, and two rubber-tyred wheels.

An advantage of these simple trucks is their manoeuvrability in confined spaces, even when being used to transport quite heavy loads. The maximum load varies between 100 kg for light-weight trucks, to 300 kg.

GEEST OVERSEAS MECHANISATION LTD.
Marsh Lane, Boston
Lincolnshire PE21 7RP, U.K.

J.J. BLOW LTD.
Oldfield Works, Chatsworth Road
Chesterfield S40 2DJ, U.K.

RICHARD FILS, S.A.
B.P.1, 33145 Saint-Michel-de-Fronsac
FRANCE

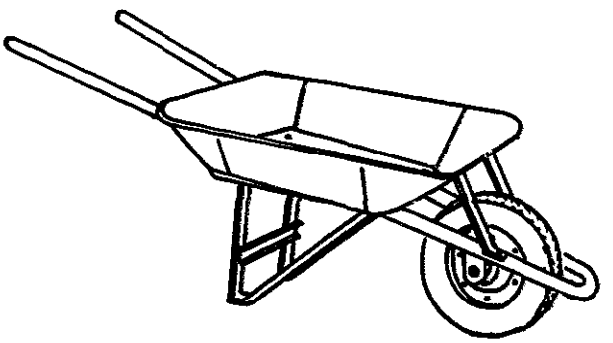


HAND TRUCKS

Although less robust than the sack and case trucks, this type of hand cart is able to handle bulkier loads. This is afforded by the larger loading pallet to which 2 swivel (front) and 2 rigid (back) casters are fitted. The casters give the truck a good manoeuvrability even when carrying capacity loads (120-500 kg according to model and manufacturer).

COSMO INCORPORATED
Towa Bldg 4th Floor
10,4 — Chome, Awaji-Machi
Higashi-Ku, Osaka
JAPAN

J.J. BLOW LTD.
Oldfield Works, Chatsworth Road
Chesterfield S40 2DJ
U.K.



WHEELBARROWS

The manufacturers listed here produce wheelbarrows which have the following characteristics:

- basic one-piece tubular frame and handles;
- rest supports and barrow mountings bolted to the frame;
- single front-mounted wheel;
- capacity of around 60 litres.

Solid tyre:
HELIMAGRO
Apartado Aereo 1003, Manizales
COLOMBIA

Solid or pneumatic tyre, or steel rim:
PONTAL MATERIAL RODANTE S.A.
Vila Independincia, Caixa Postal 8333
01.000 — São Paulo, SP
BRAZIL

Solid tyre:
KUMAON NURSERY
Ramnagar — 244715, Nainital U.P.
INDIA

Solid tyre:
ZANA ZA KILIMO LTD.
P.O. Box 1186, Mbeya
TANZANIA

Solid tyre:
RAJAN UNIVERSAL EXPORTS (MFRS.) PVT. LTD.
Post Bag 250, Madras 600 001
INDIA

Solid tyre:
SYNDICAT DE L'OUTILLAGE AGRICOLE ET HORTICOLE
15 Rue Beaujon, 75008 Paris
FRANCE

Solid and pneumatic tyre:
RYLAND (ENGINEERING) LTD.
Ryland Works, Newbold Road
Chesterfield S41 7PB
U.K.

Solid tyre:
CEAF
s.n.c. F.lli Siletti, 24034 Cisano
Bergamasco
ITALY

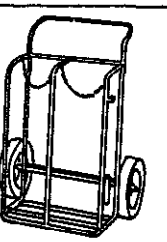
Solid tyre:
J.J. BLOW LTD.
Oldfield Works, Chatsworth Road
Chesterfield S40 2DJ
U.K.

Steel rim or solid tyre:
SARVODAYA KANDY
Pallatalawinna
Katugastota, Kandy
SRI LANKA

Solid tyre:
RICHARD FILS, S.A.
B.P.1 33145 Saint-Michel-de-Fronsac
FRANCE

Solid or pneumatic tyre:
COSMO INCORPORATED
Towa Bldg 4th Floor
10,4 — Chome, Awaji-Machi
Higashi-Ku, Osaka
JAPAN

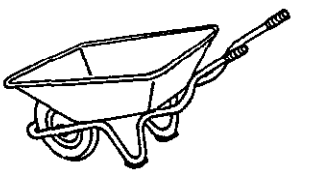
Solid tyre:
GEEST OVERSEAS MECHANISATION LTD.
Marsh Lane, Boston
Lincolnshire PE21 7RP
U.K.



WELDER'S TROLLEY

Constructed of light tubular steel, this specialist trolley is equipped with a welding rod holder and chains to hold 2 gas cylinders in position. Useful in small rural workshops.

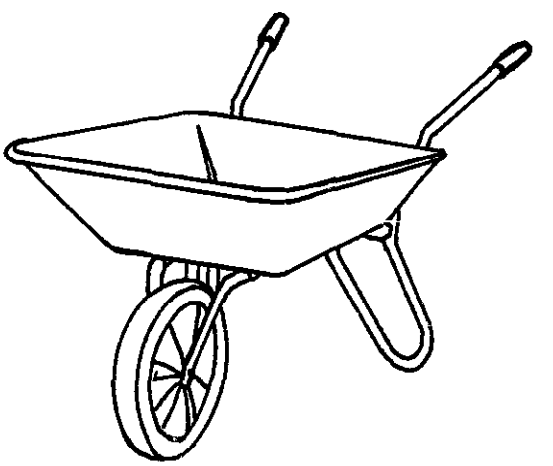
GEEST OVERSEAS MECHANISATION LTD.
Marsh Lane, Boston
Lincolnshire PE21 7RP
U.K.



HEAVY-DUTY WHEELBARROW

The 'Steadfast' is a large capacity (120 litres) wheelbarrow with a seamless, pressed body, one piece tubular steel frame and pneumatic-tyred wheel. Its robust construction makes it suitable for farm or construction work.

GEORGE H ELT LTD.
Eltex Works, Bromyard Road
Worcester, WR2 5DN
U.K.



WHEELBARROWS

These wheelbarrows are distinguished by a two-piece, tubular steel frame and handles attached directly to the wheel axle.

Solid tyre: kit form
RYLAND (ENGINEERING) LTD.
Ryland Works, Newbold Road
Chesterfield S41 7PB
U.K.

Solid tyre:
RICHARD FILS, S.A.
B.P.1, 33145, Saint-Michel-de-Fronsac
FRANCE

Solid or pneumatic tyre:
COSMO INCORPORATED
Towa Bldg 4th Floor
10,4 — Chome, Awaji-Machi
Higashi-Ku, Osaka
JAPAN

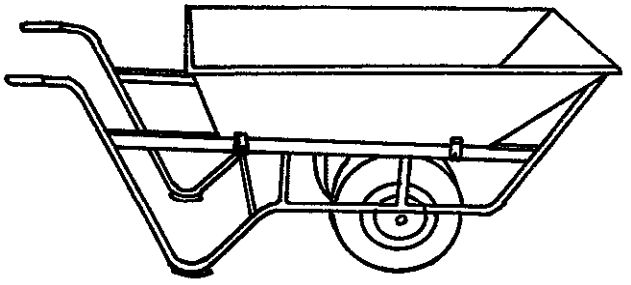
Solid tyre:
AB NORBERGS SPAD & REDSKAPSFABRIKER
Vintergatan 7, 59132 Motala
SWEDEN

Steel rim:
PERFOR
Apartado 18
4486 S Mamede de Infesta Codex
PORTUGAL

THE 'KANDY' DESIGN WHEELBARROW

A solidly built wheelbarrow designed in Sri Lanka, the 'Kandy' design is constructed from locally available GI sheets and pipes of approximately 70 litres, and is available with either steel or solid-tyred wheels.

SARVODAYA KANDY.
Pallekelewinna, Kalugalaiola, Kandy
SRI LANKA



TWO-WHEELED BARROWS

With capacities of around 100 litres, these barrows, while less manoeuvrable, offer greater stability than single-wheel models. GEEST model illustrated.

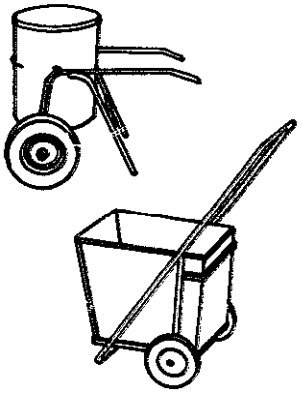
Steel-wheeled barrow:
KUMAON NURSERY
Ramnagar — 244715, Nainital, U.P.
INDIA

GEEST OVERSEAS MECHANISATION LTD.
Marsh Lane, Boston
Lincolnshire PE21 7RP, U.K.

RAJAN UNIVERSAL EXPORTS (Mfrs.) PVT. LTD.
Post Bag 250, Madras 600 001
INDIA

H.C. SLINGSBY PLC
Preston Street
Bradford BD7 1JF, U.K.

SZEGEDI VAS-ES FEMIPARI SZOVETKEZET
H 6724 Szeged, Katay u.23
HUNGARY



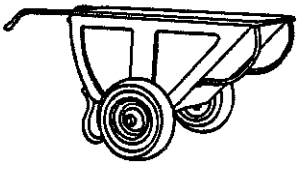
BIN CARRIERS

The 'Gari' cart (top) has an independent chassis and container which can be used separately. The chassis is of steel tubing and the galvanized container has a 100 litre capacity. A container lid is optional, as are pneumatic as opposed to solid tyres.

PONTAL MATERIAL RODANTE S.A.
Vila Independencia, Caixa Postal, 8323
01.000 — São Paulo, SP
BRAZIL

The bin carrier (bottom) is designed to carry a square container as shown. Again the chassis is of tubular steel, while the container is equipped with slot handles to enable easy removal

J.J. BLOW LTD.
Oldfield Works, Chatsworth Road
Chesterfield S40 2DJ
U.K.



TWO-WHEELED BARROWS

These all-purpose barrows have capacities of 100 to 200 litres.

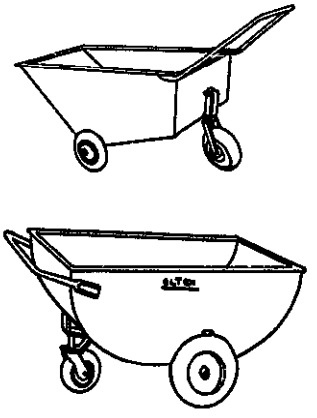
Solid tyre:
SYNDICAT DE L'OUTILLAGE AGRICOLE ET HORTICOLE
15 Rue Beaujon, 75008 Paris
FRANCE

Solid or pneumatic tyre: 100 litres

COSMO INCORPORATED
Towa Bldg 4th Floor
10, 4 — Chome, Awaji-Machi
Higashi-Ku, Osaka
JAPAN

Solid or pneumatic tyre: 150 litres
MASCHINENFABRIK HEGER GmbH
Zaberstraße 26, 7033 Herrenberg 1
W. GERMANY

Nylon-banded wheel:
HIGHLIGHT ENGINEERING CO. LTD.
Highlight Engineering Works
Dunnington, Yorkshire YO1 5LP
U.K.



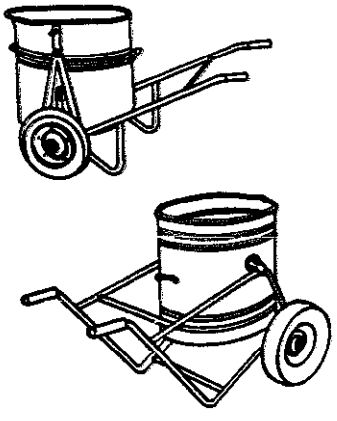
FODDER BARROWS

The fodder barrows illustrated here are light-weight containers with capacities of 150 litres and 250 litres (top and bottom respectively). The rear wheels being of the jockey type, the barrows are easily manoeuvrable, and can be employed for a wide range of light-duty tasks.

The barrow produced by G. Elt (bottom), in addition to standard solid rubber tyres, is available with pneumatic-tyred wheels.

MASCHINENFABRIK HEGER GmbH
Zaberstraße 26, 7033 Herrenberg 1
W. GERMANY

GEORGE H ELT LTD.
Eltex Works, Bromyard Road
Worcester WR2 5DN
U.K.

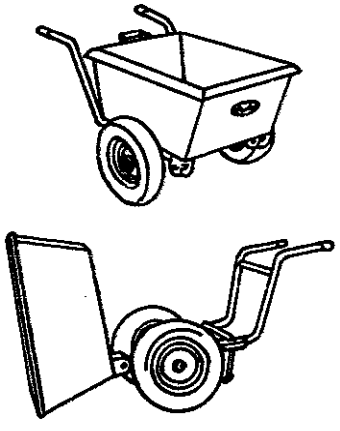


WATER BARROWS

The galvanized container pivots on a horizontal axis and is manufactured with a pouring lip. Container capacities available are 100 litres and 150 litres. The chassis is of tubular steel and has two wheels with solid rubber, or, (for models produced by G. Elt), pneumatic tyres.

GEORGE H ELT LTD.
Eltex Works, Bromyard Road
Worcester WR2 5DN
U.K.

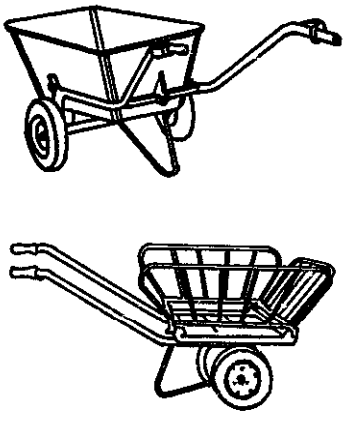
GEEST OVERSEAS MECHANISATION LTD.
Marsh Lane, Boston
Lincolnshire PE21 7RP
U.K.



THE 'MAUA' TROLLEY

The 'Maua' Trolley is a tipping barrow with a 100-litre capacity reinforced container. It is supported on an iron chassis and two solid-tyred wheels, the 'foot' being centralized for maximum stability while stationary. The tubular steel handles given an overall maximum length of 1.18 metres while maximum height and width are 0.59 and 0.75 metres respectively.

PONTAL MATERIAL RODANTE S.A.
Vila Independência, Caixa Postal 8333
01.000 — São Paulo, SP
BRAZIL

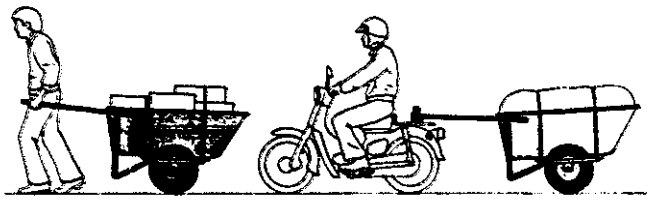


UNIVERSAL FARM WHEELBARROW

This wheelbarrow is intended to be used for the short-distance transportation of farm produce. It is also suitable for carrying fodder and feed stuffs, sand, cement and other building materials.
Load capacity: 300 kg
Cubic capacity: 160 litres
Platform size: 0.7m2
Platform capacity (with railing): 0.8m3

The wheelbarrow is equipped with pneumatic tyres and has an overall weight of 80kg. Manufactured by: Zaklad Wyrobow Metalowych 'Strumet', and available through:

AGROMET MOTOIMPORT
Foreign Trade Enterprise
P.O. Box 990, Warsaw
POLAND

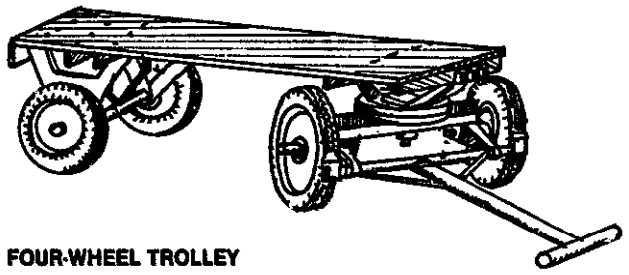


REAR CART

An all-purpose 300 litre capacity cart which can either be hauled by hand or adapted for pulling by a motorcycle. The bucket is a robust press-moulded construction reinforced by steel pipes at the edges. Both pneumatic and solid tyres are available. Other specifications include:

- weight of car: 39.5 kg
- max loading: 300 kg.

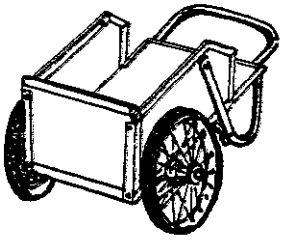
COSMO INCORPORATED
Towa Bldg 4th Floor
10,4 — Chome, Awaji-Machi
Higashi-Ku, Osaka
JAPAN



FOUR-WHEEL TROLLEY

Available with a timber platform (160 x 80cm or 200 x 100cm), this wagon is able to carry loads of up to 750 kg. It is equipped with a wide T-shaped handle with a cross-bar fitted to the front wheels which are attached to the main chassis by a bogey arrangement. The wheels are fitted with pneumatic tyres.

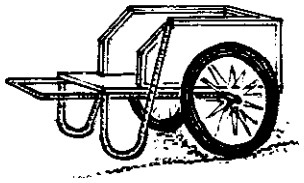
PONTAL MATERIAL RODANTE S.A.
Vila Independência, Caixa Postal 8333
01.000 — São Paulo, S.P.
BRAZIL



THE GARDENWAY CART

Able to carry up to 180 kg, the Gardenway cart is available in 3 sizes. The barrow is constructed of bolted panels and ridges on 2 custom-made pneumatic-tyred wheels.

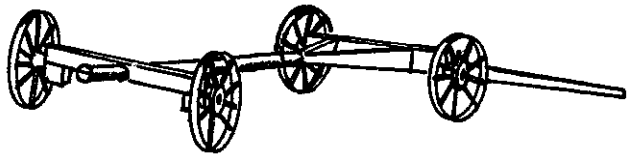
GARDEN WAY RESEARCH
110 Ferry Road, Charlotte, VT 05445
USA



LIGHT 'ECONOMIC' HAND CART

Designed, economically, to carry up to ¼ tonne of farm produce, fertilizer, etc. over village roads, estates etc. Often replaces the need for a single-bullock cart. Very easily propelled by hand, even over rough roads.

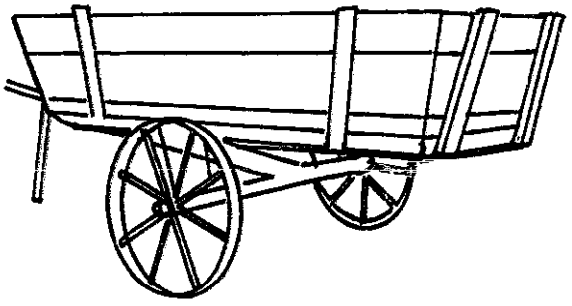
LIGHT ENGINEERING INDUSTRIES
127 Kottawa Road
Nugegoda
SRI LANKA



MODEL SW68 FARM WAGON

The SW68 farm wagon is a heavy-duty vehicle capable of carrying loads of up to 6 tonnes. A telescoping beam allows the wagon's length to be varied according to requirements. Other specifications are:
Bearings: tapered roller type
Track: 150 cm
Tongue: ash with pole cap and hammer strap
Wheels: spoked, forged steel.
Accessories available include bolster springs, wooden eveners and swingle trees, wooden neck yokes and steel clevises.

D.A. HOCHSTETLER AND SONS
R.R.2, Box 162, Topeka, IN 46571
U.S.A.



ANIMAL-DRAWN CARTS

The following carts are of a simple design with either steel or wooden wheels.
FARM CART (illustrated). A bullock or horse-drawn cart constructed of steel and wood. The side, back and front panels are removable.

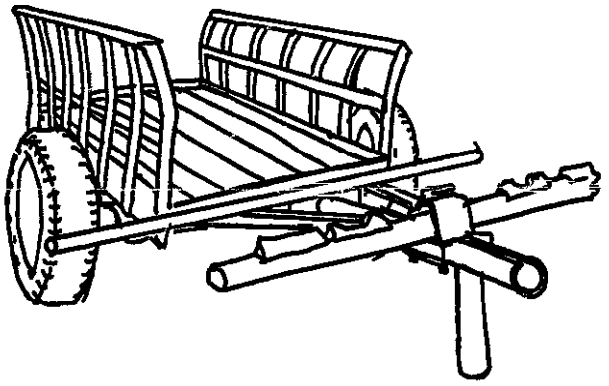
ELISHA ENGINEERING
36 Nabeka Street, P.O. Box 42, BA
FIJI

FARMKART. A 1.5 tonne capacity animal-drawn cart supplied in bolt-together kit form. A choice between plain or roller bearing hubs is available, as is an optional braking assembly. The kit includes necessary tools and instructions for assembly, although it is recommended that wooden components for the superstructure are obtained locally.

FARMKART LTD
P.O. Box 246, Jersey, C.I.
U.K.

OX-CARTS. Produced as part of an agricultural extension programme in Kenya, these wooden carts are robust and may be used for a wide range of tasks. The cart has an overall length of 2.5 m and is equipped with a braking mechanism.

LUGARI EXTENSION PROGRAM
Appropriate Implements Project
P.O. Box 125, Soy
KENYA



ANIMAL-DRAWN CARTS

The following carts are heavy-duty vehicles equipped with pneumatic tyres.

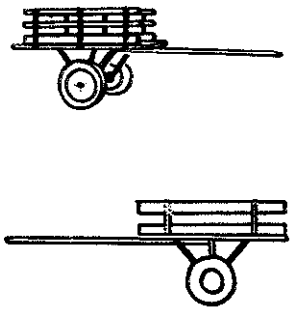
'FERRO' HAY WAGON. This large ox-drawn cart has a capacity of 1,600 kg (8m³) and is equipped with pneumatic tyres on request. The platform dimensions are 2.6 by 1.7 m, while unladen weight is 350 kg, and total width is 1.4 m.

SHEET-METAL OX-CART. Similar to the hay wagon, apart from a slightly smaller platform size (2.4 x 1.5 m) and lower unladen weight (220 kg).
The Hay Wagon and Ox-cart are manufactured by:

SISMAP
B.P. 3214
20 Rue Dr. Theze
Dakar
SENEGAL

BULLOCK CART. Designed by Maharashtra AIDC to optimize load and required draught power, this cart (illustrated above) has a capacity of 3,000 kg. Constructed of mild steel it is equipped with a main axle roller bearing and pneumatic tyres. If required the axle position can be adjusted to suit the load. Brakes are optionally available.

MAHARASHTRA AGRO IND. DEV. CORP. LTD.
Rajan House, 3rd Floor
Near Century Bazar, Prabhadevi
Bombay 400 025
INDIA



DONKEY CARTS

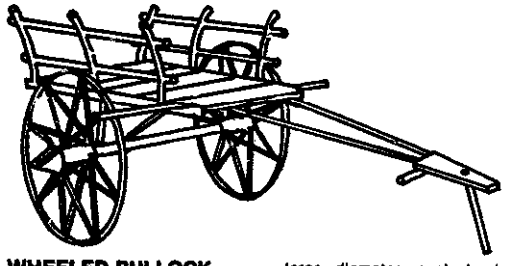
The model produced by SISMAR (top left), has a loading platform measuring 1.6 x 0.95 m and a capacity of 500 kg. The body is supported by the axle, which is fitted with tapered roller bearings and 2 pneumatic-tyred wheels.

A similar donkey cart is manufactured by Arar (bottom left). This model has a payload of 3-400 kg.

Both vehicles have slatted wooden sides and an unladen weight of about 108 kg.

SISMAR
B.P. 3214
20 Rue Dr. Thaze
Dakar
SENEGAL

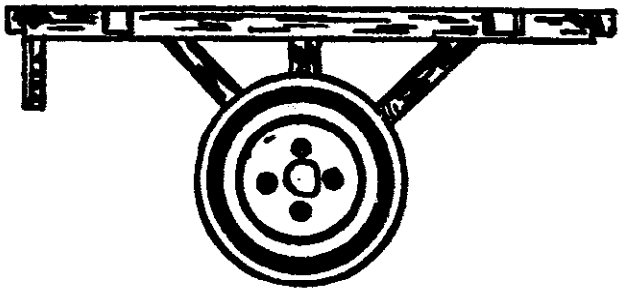
ARARA
30 Rue d'Anjou, 7800 Versailles
FRANCE



STEEL-WHEELED BULLOCK CART

Designed for use on unmade roads, these bullock carts are of a simple construction, and may be made up or maintained by local craftsmen. The chassis is fabricated of tubular steel sections upon which wooded boards are fitted to form the loading pallet. The large diameter, spoked wheels are formed from flat iron, the hubs being mounted on plain bearings.

MAHARASHTRA AGRO INDUS. DEV. CORP. LTD.
Rajan House, 3rd Floor
Near Century Bazar, Prabhadevi
Bombay 400 025
INDIA



ANIMAL-DRAWN CARTS FROM BURKINA FASO (UPPER VOLTA)

CNEA have developed the following carts:

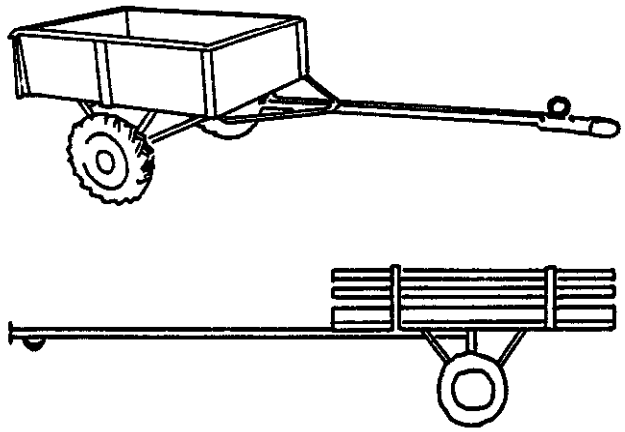
SMALL-PALLET, MULTI-PURPOSE CART (La Charrette Petit Plateau Polyvalente). Designed to be drawn by either mule/ass or ox, this cart is constructed from an angle-iron frame on which a sheet-metal pallet is bolted. The chassis and axle, also of angle-iron (heavy duty), is fitted with two pneumatic-tyred wheels. The pallet is 1.8m long by 1.3m wide and has a loading capacity of 500kg.

LARGE-PALLET, MULTI-PURPOSE CART (La Charrette Grand Plateau). Although essentially similar in design to the small pallet cart, this model is equipped with a larger (2.0 x 1.6m) loading pallet which has a capacity of 1,000 kg. Required draught power is provided by a pair of oxen.

DUMPCART (La Charrette Tombereau). A 500 kg (450 litre) capacity cart which can be drawn by either a single ass/mule or oxen.

The cart has a sheet-metal floor, with similar side, back and front panels, bolted to an angle-iron frame. The front and back panels can be removed for unloading purposes. The wheels are fitted with pneumatic tyres and are protected by plates projecting from the side panels.

C.N.E.A.
B.P. 7240, Ouagadougou
BURKINA FASO



HEAVY-DUTY ANIMAL-DRAWN CARTS

The following ox-carts, which are similar to the models illustrated, are suitable for heavy-duty materials transport work.

1 TONNE ANIMAL-DRAWN CART. Based on an indigenous African design, this cart is equipped with pneumatic tyres and roller-bearing hubs. It is possible to dismantle the cart completely for transportation.

PETROLEUM SERVICES (MALAWI) LTD.
Barnes Rd, Ginnery Corner
P.O. Box 1900, Blantyre
MALAWI

HOLTAG OX-CART. A 2-tonne capacity bullock cart with pressed steel chassis and wooden sides. It is mounted on pneumatic-tyred wheels with roller bearings.

JOHN HOLT AGRIC. ENGINEERS LTD.
New Industrial Estate
P.O. Box 352, Zaria, Kaduna State
NIGERIA

FARM SCOTCH CART (top illustration): a very robust design with steel chassis and heavy-tread pneumatic tyres. The body is of pressed steel with detachable tailboard.

BAIN MANUFACTURING COMPANY (PVT) LTD.
Box 1160, Harare
ZIMBABWE

OX-CART (bottom illustration): this cart is designed for c. 1000 kg payload. The steel chassis and pneumatic tyres support a superstructure of wooden slats.

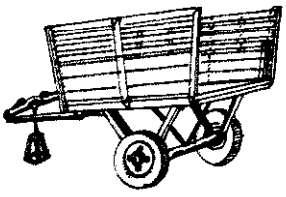
ARARA
33 Rue d'Anjou, 7800 Versailles
FRANCE

OX-CART: with a payload of 1500 kg, this heavy-duty cart is equipped with a rugged chassis and axle assembly. The wheel hubs run on tapered roller bearings and are sealed against dust. 6-ply implement tyres are fitted. The wooden floor, side and front boards (reinforced) are bolted on, allowing easy transport. A tailboard is supplied on request.

PROJECT EQUIPMENT LTD.
Industrial Estate, Rednal Airfield
West Felton, Oswestry
Salop, SY11 4HS
U.K.

THE GP1000 'CHARRETTE' FLAT CART: a 1,000 kg capacity cart, the 'Charrette' features an adjustable mechanism that enables the loading pallet to be inclined at an angle. The steel chassis and pneumatic tyres support the pallet which is 2 m in length by 1.6 m wide.

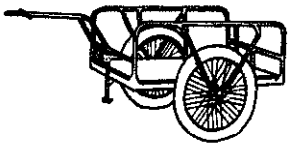
UPROMA
B.P. 1086, Lomé
TOGO



SINGLE BULLOCK-DRAWN CART

Fabricated from wooden planks mounted on an angle-iron frame, the cart superstructure is mounted on 2 half-axles with cast-iron hubs. The hubs are fitted with roller bearings, brakes and pneumatic tyres.

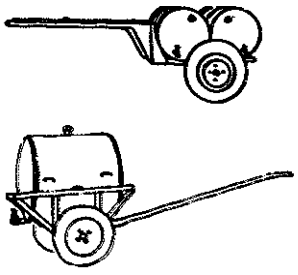
SATHIYAWADI STORES AND MOTOR TRANSPORTERS LTD.
P.O. Box 42, Kurunegala
SRI LANKA



SMALL ANIMAL-DRAWN CART

Suitable for single animal draught (e.g. mule or donkey), this cart is equipped with tubular steel chassis and railings, wooden platform and spoked pneumatic-tyred wheels.

TROPIC
B.P. 706, Douala
CAMEROUN



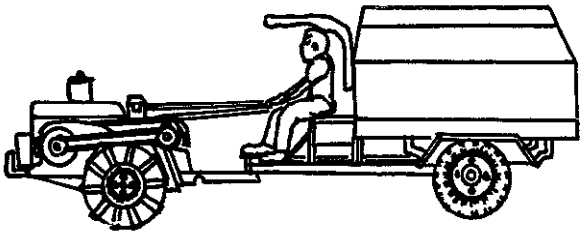
WATER TANK CARRIERS

Sismar produce two animal-drawn water tank carriers.

The donkey-drawn 'Marnane' (top left) is equipped with 2 pneumatic-tyred wheels and is able to carry 2 x 180 litre water tanks. Its unladen weight is 200 kg.

The 'Super Marnane' (bottom left) is designed to be drawn by a single ox. The heavy-duty, angle-iron chassis rides on 2 pneumatic-tyred wheels, and supports a single, large cylindrical water tank. Its unladen weight is 290 kg.

SISMAR
B.P. 3214
20 Rue Dr. Thaze
Dakar
SENEGAL



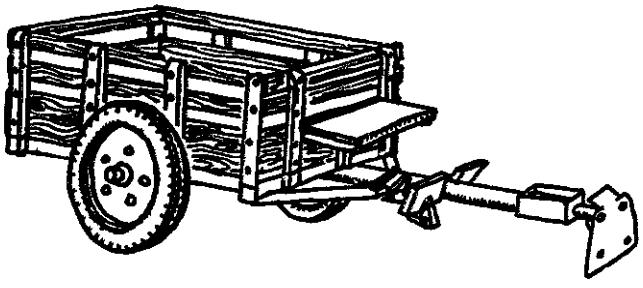
THE HIPPO HAULER

The Hippo Hauler delivers a 1,500 kg payload at speeds of up to 21 km per hour. It is equipped with a 7/8 HP diesel power tiller which gives a mean fuel consumption of 17 km per litre. This will vary according to terrain and road conditions.

A simple coupling device allows more than one trailer to be used. Alternatively the existing chassis can be adapted to meet the requirements of the user — for example, it is able to accommodate a 1,500 litre water tank.

The Hippo Hauler has an unladen weight of 500 kg.

KRISHI ENGINES LTD.
A-7 Unit, Sanatnagar
Hyderbad 500 018, A.P.
INDIA



TWO-WHEELED TRACTOR-DRAWN CARTS

The following carts can be adapted for draught by a 2-wheeled tractor (power tiller):

AGRICULTURAL TRAILER, MODEL 7C1: This trailer is available as a complete set with a 12HP tractor. It can be used for the transport of most agricultural produce and equipment, and has a payload of 1,000 kg. The unladen weight of the trailer is 354 kg.

CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeulan Street, Beijing
CHINA

1 TONNE TRAILER: The angle-iron and wood superstructure is supported by a channel-iron chassis which runs on a mild steel rod axle with roller bearings. The wheels are fitted with expanding type brakes. The draw-bar, which is made of mild steel rod, is equipped with a coupling device and foot brake pedal.

SATHIYAWADI STORES AND MOTOR TRANSPORTERS LTD.
P.O. Box 42, Kurunegala
SRI LANKA

THE TODATTA TRAILER (illustrated): The heavy-duty all-steel chassis supports a wooden superstructure with a capacity of 750 kg, and long pole tow-bar and coupling device. The cart is also equipped with a driver's seat and foot-plates.

An interesting feature of this model is that its axle and wheel hub is designed to take automobile wheels in place of the standard wheels supplied by the manufacturer. Because the former are larger than the standard wheel size, the axle height can be adjusted to bring the cart chassis into line with the pulling tractor.

PONTAL MATERIAL RODANTE S.A.
Vila Independência, Caixa Postal 8333
01.000 — São Paulo, SP
BRAZIL

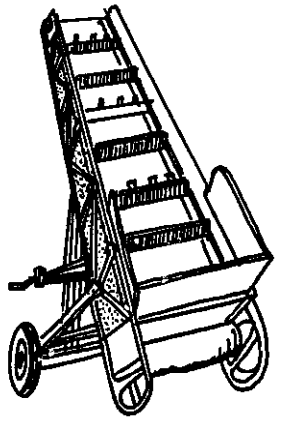
MOBILE CONVEYORS

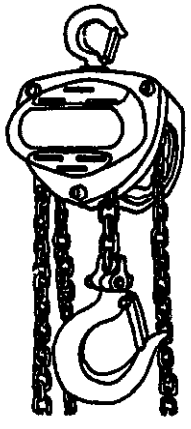
The 'Ravenna' conveyor (pictured left) is an all-purpose conveyor available in standard 4-12 m lengths. The conveyor belt, which runs at about 0.9 m per second, is supplied in either 30 or 65 cm widths, and is treaded according to the users' needs. The drive unit can be either AC, DC, petrol or diesel motor, while the height may be adjusted by cable winch.

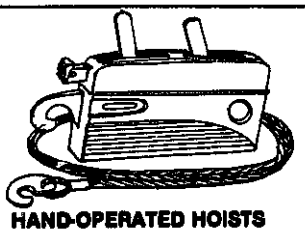
HINGHAUS MASCHINENFABRIK GmbH
Kampenstraße 9, 4804 Versmold
Westfalia
W. GERMANY

Also available is a mobile screw conveyor. With a choice of diameters (100 mm or 135 mm), and variable length (3-10m), an output of 4-15 tonnes per hour can be obtained according to the slope setting.

MASCHINENFABRIK HEGER GmbH
Zaberstraße 26, 7033 Herrenberg 1
W. GERMANY







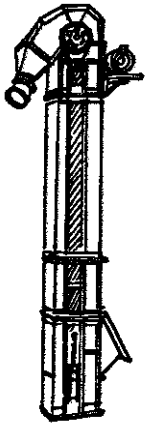
HAND-OPERATED HOISTS

A lightweight heavy-duty hoist (left) lifts from 500kg to 20 tonnes and can be supplied with either hook suspension or built into a travelling trolley.

HERBERT MORRIS LTD., P.O. Box 7
North Road, Loughborough
Leicestershire LE11 1RL, U.K.

The 'Jockey' winch hoist (above) is for pulling and lifting operations. Rec. limits: 300 kg lifting, 500 kg pulling.

TIRFOR LTD.
Halfway, Sheffield S19 5GZ, U.K.

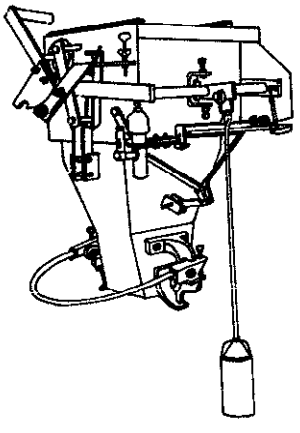


VERTICAL BUCKET ELEVATOR

Elevators can provide a useful service in continuous lifting operations such as grain loading. This Indian-manufactured elevator is an all-steel construction driven by a small electric motor which can be used on a 400/440 V — 3 phase 50 cycle mains supply. High-speed buckets are mounted on a multiple-ply rubber belting, and non-slip pulleys are used in the end sections.

The electric motor is supplied with the elevator.

COSSUL & CO. PVT. LTD.
123/367 — Industrial Area
Fazalganj, Kanpur, U.P.
INDIA



AUTOMATIC BAGGER AND WEIGHER

Oriental Workshops produce 3 models of this machine which automatically bags and weighs farm produce such as grain. It is able to handle loads of 1-15 kg (Precision model), 5-50 kg (Master model) and 10-100 kg (Super model) with an accuracy of ±0.1%.

The bagging and weighing process is achieved through a balance assembly which is controlled by a piston set in an oil bath. The piston movements are damped by a rod and rocker mechanism which minimizes oscillations of the balance and speeds up the bag-filling operation.

ORIENTAL SCIENCE APPARATUS WORKSHOPS
Jawaharlal Nehru Marg
Cantt — 133001, Haryana
INDIA

10. LIVESTOCK HUSBANDRY AND HEALTH

Threshing Rice in Sri Lanka.

It is a paradox that in developing countries, which raise the majority of the world's livestock (see Table 1) and where livestock forms the backbone of food production systems, most livestock husbandry systems use few tools. Animals provide much of the power used in the world's agriculture. They also provide a significant proportion of the protein consumed by people.

An extensive range of equipment has been developed for large-scale intensive livestock production systems, but most of the smaller scale husbandry systems used by poorer livestock farmers in developing countries could not justify the use of or support the cost of this equipment. What is attempted in these pages, therefore, is to highlight aspects of livestock health and husbandry, which are essential to optimizing productivity, and to make reference to equipment which is available for this purpose and which could enhance lower-cost production systems. For the purposes of this introduction livestock production is divided into reproduction, rearing, feeding, general health care and a note on milking, a particularly important non-destructive method of harvesting animal products. The other non-destructive ways of harvesting animal products are through egg production and wool production (see Section 11).

Reproduction

Poor control in maximizing the reproductive abilities of livestock is perhaps the cause of more losses than in any other sphere of livestock husbandry.

Record keeping

A major part of reproduction management is the keeping of accurate records. For instance dairy cattle calving calendars can be used to remind stock keepers when

cows last came into oestrus, when they are due to calve, and so on.

Identification

The ability to identify animals is, of course, important for many reasons and is the initial step required in any scheme to improve the productivity of livestock. Table 2 gives a number of identification methods available for animals.

Table 1. Livestock populations in developed and developing countries. (W.J.A. Payne 1981).

Type of livestock	*Livestock as a % of total world population*		
	Developed countries	*Centrally planned economies*	*Developing countries*
Camels	0.1	5.9	94.0
Cattle	25.0	17.0	58.0
Buffaloes	0.1	25.9	74.0
Sheep	34.0	25.0	41.0
Goats	6.0	17.0	77.0
Pigs	26.0	57.0	17.0
Fowls	28.0	42.0	30.0
Ducks	8.0	35.0	57.0

Ear tags are perhaps one of the most widely used methods of identification and are available in both plastic and aluminium. Some companies will provide an individual herd identification as well as tags numbered serially for the identification of each animal. The one major disadvantage is that they can be pulled or torn out and are therefore likely to have to be replaced from time to time.

Tatooing is also widely used in some countries. The initial cost of the instrument is relatively high but if well looked after one instrument should last for many years. The main advantage of the system is that, if properly used, the tatoo should last for the lifetime of the animal. The disadvantages include the fact they may be difficult to see in dark skinned animals. It is also necessary to catch the animal in order to be able to identify it. It is possible to tatoo in the caudle fold, but it is a method which is less frequently employed than ear tatooing.

Leg bands are sometimes used, to identify dairy animals when coming through a parlour to be milked, although they are occasionally used on other species as well. Different colours, as well as letters and numbers, can be used to help with identifying particular groups of animals.

Tail bands are also used particularly in the cattle industry for the identification of particular groups of animals.

Table 2. Identification methods available for animals.

	Cattle/ buffalo	*Sheep/ goats*	*Pigs*	*Poultry*	*Horses*
Ear tags	●	●	●	(wing)	—
Tatoos (ear)	●	●	●	—	—
Leg bands	—	●	—	●	—
Branding	●	—	—	—	●
Ear notching	—	—	●	—	—
Hair/fleece marking	●	●	●	—	—

Branding. The traditional hot branding of livestock, particularly cattle, is widely used in many countries and results in a permanent scar on the skin. Its main disadvantage lies in the damage to the hide when it is being used to make leather.

Freeze branding using liquid nitrogen is increasing in popularity and is relatively painless, but requires rather more expensive equipment than that for hot branding, including the provision of a liquid nitrogen source.

Hoof branding of horses is carried out in some countries and this is done with a hot iron placed directly on a horse's hoof immediately below the coronet. The brand will obviously grow out with the hoof and will need replacing from time to time.

Ear notching is used in a number of species, but particularly perhaps in pigs, to identify animals from different litters. The principal disadvantage of this method is that occasionally the ears get torn and so obliterate the ear notches.

Marking is widely used for the semi-permanent identification of sheep and other animals — with dye in a paint, wax stick or aerosol spray.

Heat (oestrus) detection

The detection of oestrus in livestock is perhaps one of the most important methods of maximizing reproduction. In cattle and goats oestrus detection is monitored by changes in behaviour. The marking of ewes that have been served by a ram, by means of a raddle attached to the brisket of the ram with a harness, greatly aids the monitoring of mating of the species. The colour of the raddle should be changed every 17 days so as to identify those ewes which are served more than once. It is of principal use in countries away from the equator where there is a distinct reproductive season.

Horses are usually hand mated and the detection of oestrus in this species is normally done by leading the mare past the stallion and noting the reaction. This method is called teasing. Sows, when housed next door to a boar, will lie along the fence adjacent to the boar's pen, if they are in oestrus.

Artificial insemination

The use of artificial insemination as a means of reducing the number of entire males and of improving their quality is being increasingly used in most countries. Semen can either be stored chilled at about 4°C, in which case its life is limited to a few days, or stored frozen, usually in liquid nitrogen, which prolongs its life indefinitely. The processing and freezing of cattle semen presents few, if any, problems whilst that of goats has until recently been much more difficult. These problems have, however, largely been overcome. The same is not true of sheep and pig semen which are still usually not frozen. The processing of semen requires relatively complex equipment and is outside the scope of this guide.

Frozen semen is usually stored in either straws or pellets and is kept frozen in flasks of liquid-nitrogen until immediately prior to being used. Although modern cylinders do not have to be refilled for up to four months it is important to secure a reliable source before embarking on the keeping of frozen semen.

Providing suitable training is available, insemination itself requires little or no equipment except for a 'gun' to introduce the semen into the cervix and expell the semen

Treatment by a village health worker.

from the straw, and, for smaller species, a speculum to guide the semen into the cervix.

Care of the pregnant animal

Pregnancy diagnosis in cattle and horses is usually done manually by palpation of the uterus through the rectum. In sheep, goats and pigs ultrasonic pregnancy diagnosis detectors are available. The probe is either placed externally on the abdomen or introduced into the rectum. These instruments are constantly being improved, but already accurate pregancy diagnosis is possible from a few weeks after service. Laboratory diagnosis of pregnancy can be achieved by measuring hormone levels in blood or milk. These methods are widely used for pregnancy diagnosis in cattle, horses and goats, but they require a certain amount of sophisticated laboratory equipment and technicians trained in their use.

Table 3 shows the comparative reproduction data for goats, sheep, cattle and buffaloes.

Incubation of eggs

The most usual method of incubating eggs is, of course, a live bird either as the real parent or foster parent. However, poultry incubators with varying degrees of sophistication, including automatic turning of the eggs, and controlled humidity, temperature and air flow, are available for all species.

Parturition

Many deaths of mothers and newborn animals which occur at or immediately after parturition are avoidable given sufficient attention and equipment to deal with problems. The vast majority of animals will, of course, give birth without any outside interference and it is often a question of fine judgement as to when outside interference is required. Table 4 shows the normal gestation period for domestic animals including poultry.

Table 4. Gestation Periods

Buffalo	10 months
Cattle	9 months
Sheep	148 days
Goats	151 days
Horses	11 months
Pigs	113 days
Chickens	21 days
Ducks	28 days
Geese	29-31 days
Turkeys	28 days

Birthing aids

Calving ropes are useful to aid difficult or delayed parturition in cattle and horses and they may also be used in sheep and goats. Mechanical calf pullers may be used to attach calving ropes to, and they can be used to apply enormous force to the calf. In inexperienced hands they are, however, of considerable danger as, unless the reproductive canal is sufficiently open to allow the calf to come out, great damage can be done to both calf and mother.

On occasions where either the calf is so deformed or the reproductive canal is too small, embryotomy may be necessary. The usual method is to cut off parts of the foetus by means of embryotomy wire introduced into the uterus via a double tube, and operated from the outside.

Prolapse restrainers

Before parturition, internal pressure due to the increased size of the uterus may cause the cervix to prolapse. This must be replaced and held in position until the pressure is released at parturition. Various trusses and retaining aids are available for this purpose. A prolapse of the

Table 3. Comparison of reproduction data for goats, sheep, cattle and buffaloes.

	Goats	*Sheep*	*Cattle*	*Buffaloes*
Age at puberty (months): male	4-5	7-8	6-10	18
: female	4-5	4-15	6-10	13-19
Age at first service (months): male	6-7	9-12	12	18
: female	7-18	9-18	14-22	14-25
Seasonal reproduction	Yes	Yes	No	No
Oestrus cycle (days)	18-21	17	21	21
Duration of oestrus (hours)	36-96	36	18	11-72
Time of ovulation in relation to oestrus (hours)	36-48 after beginning	18-40 after beginning	14 after end	—
Gestation length (days)	150	147	280	310
Dependence on corpus luteum throughout pregnancy	Yes	No	No	—
Silent ovulation at first cycle of breeding season	No	Yes	—	—
Signs of oestrus in absence of male	Yes	No	Yes	Few

whole uterus may occur after parturition due to continued contractions. If this can be replaced it may be held in position until the contractions stop. In this more serious type of prolapse infection is highly likely.

Farrowing crates

In many intensive systems of pig husbandry sows are confined in farrowing crates in order to reduce the risk of them lying on, or otherwise damaging the piglets. This consists of a set of horizontal tubular rails which restrict the movement of the sow and allow the piglets into an escape area which is usually warmed with an infra red light in order to attract them when they are not feeding.

Brooding cabinets and lamps

Poultry brooders are also available commercially. The main purpose of these are, of course, to allow temperature and humidity to be closely regulated in the early and most critical days of the chick's life.

Rearing

Normally young animals are reared by their mothers. If however the mother's milk is required for human consumption or the mother dies at parturition the young may have to be artificially reared.

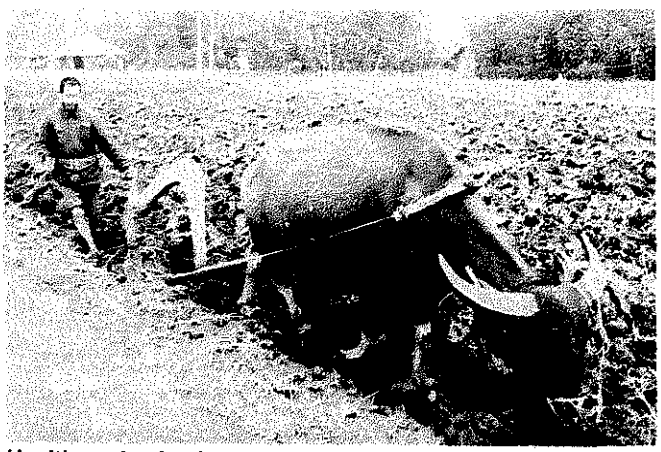
Every effort should be made to ensure the young receive colostrum, the first milk produced by the mother, before being transferred to artificial milk replacer. A wide variety of teats, buckets and cafeteria systems are available for artificial rearing. If a new born animal is very weak a stomach tube may be needed to introduce liquid food directly into the stomach.

If a foster mother is available it may be possible to persuade her to adopt an orphan. Lamb-adopting crates can be used to secure a ewe whilst she becomes accustomed to a lamb and it acquires her smell.

Feeding and watering: concentrate feeding

A wide variety of equipment is manufactured for providing concentrated feed to animals. The range extends from simple troughs to complex conveyor feeding systems for intensively kept chickens. Only the simplest equipment is covered by this guide — that which might effectively reduce food wastage.

Very rarely will the diet of livestock be complete in all the minerals required for optimum performance. Minerals, especially salt, should be provided, and a number of patent dispensers are available for this purpose. Poultry, whilst producing eggs, can often benefit from extra calcium provided in the form of crushed sea shells, e.g. oyster shell. To avoid wastage this should be provided in a specialist container.



Healthy animals give more power.

Grazing

Most domestic animals forage for the major portion of their diet. Usually they are carefully herded. In some societies grazing control is exercised communally, but in many the only way of controlling grazing, and hence the productivity of fields and pastures, is through effective fencing, which also limits the range of the animals.

Effective fencing is invaluable in both stock and grazing management. The erection of post and wire fences is made easier by the use of post-hole diggers. A post driver is easier for the inexperienced person to use than a sledge hammer and does not split the top of the fencing post. Wire strainers allow barbed and plain wire to be strained tight. Fencing pliers are invaluable for cutting and straining wire and for pulling out or knocking in staples.

Temporary electric fencing is an alternative to permanent fencing. Electric fencing systems are available which are easy to erect and may be run from mains or battery supply. Solar-powered electric fences are becoming available.

Water

Provision of sufficient clean water will enhance productivity. The watering system chosen for any animal production system will depend on the source available.

If piped water is available then an automatic system will reduce the labour requirement. It must however be checked at regular intervals.

A pasture pump can be used to provide water from underground springs or nearby water sources. These simple pumps will draw water from a depth of 8 metres and can be operated by the muzzle of an animal.

General health care: routine tasks

Castrating, tailing, disbudding, de-horning, tooth-cutting, de-beaking and foot-care are all regular husbandry tasks for which there is a range of equipment available. The most suitable equipment will depend on individual circumstance, and the species and age of the animals concerned.

Animal husbandry tasks are made easier by well thought out handling systems. These range in complexity from a simple bull nose-holder, through head bails to races and crushes in which the animal may be secured for treatment, be it foot trimming or drenching.

For sick or prone cattle there are a number of cow lifting devices available. These range from an inflatable cube to a winch which fits over the animal's pin bones.

Spraying equipment is used to apply insecticides to animals. Insects can be directly deleterious to animals because they are parasitic by nature or they may be vectors of disease.

Emergency treatment

Treatment of serious animal diseases should ideally be carried out by a trained veterinarian. In some countries however Animal Health Auxilliaries (AHAs) are responsible for the notification of the presence of disease and for the implementation of the necessary

control and preventative measures. AHAs sometimes diagnose, treat and control diseases. The veterinary equipment covered in this guide is an example of the equipment which might be used by an AHA in the treatment and control of routine animal health problems. Some of the equipment might also be valuable to an informed stock-owner.

Milking

The simplest method of milk extraction is of course hand milking. If a milking herd or flock increases in size, or if it is desirable to machine milk for reasons of hygiene, there is a range of small milking machines available.

The simplest machine-milking system consists of a pump to supply vacuum, a pulsator to regulate the alternate collapse and opening of the flexible rubber liners in each teat cup of the cluster. Lastly a bucket or churn into which the milk from the cluster is drawn under vacuum.

This system may be arranged in three ways:

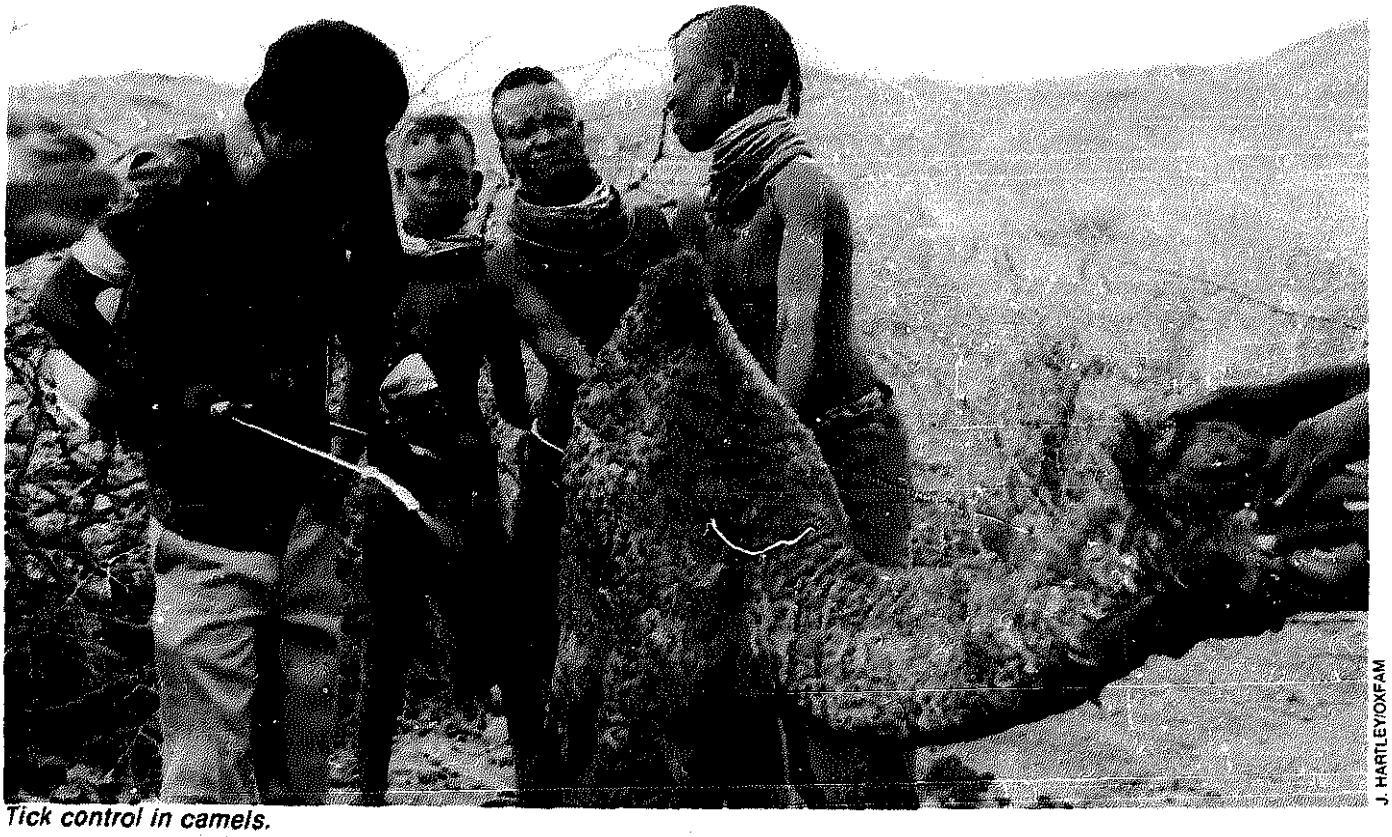
- The whole system may be mounted on a trolley for ease of mobility
- Completely mobile systems are also available in which the vacuum pump is separate from the milk storage vessel. The pump may be trolley mounted or have a carrying handle.
- Small vacuum pumps are available for use with an air line. The airline supplies vacuum to a bucket plant which is mobile.

Any milking machine should be designed to maintain the vacuum in the system at the recommended level and minimize vacuum fluctuations. The pulsators must operate at the pulsation rate and ratio of milking to non-milking phase recommended by the manufacturer. Pulsationless machines which work at continuous low vacuum are available. This method is said to ensure maximum milk extraction in minimum time. Milking machines are most commonly powered by electricity but many of the small models may be powered by a diesel or petrol motor. A hand-operated vacuum pump is also available for situations where no mechanical power source is available. This pump produces a continuous low vacuum for use with pulsationless milking equipment. Once milking is completed milk should be cooled as quickly as possible to prevent the growth of any micro-organisms present. Small bulk tanks and in-churn coolers are available for this purpose.

Additional equipment will be required if the milk is to be processed further. Equipment for processing small quantities of milk is of limited availability. Cream separators and butter churns are supplied by a number of manufacturers but small-scale cheese and yoghurt-making equipment and small cold stores are scarce and highly priced. Complete dairying installations can be provided by many companies but only one company specializes in small dairying plants for tropical and sub-tropical conditions.

Advantages

The advantages of using specialist equipment in livestock production systems are to be found in reduced labour requirement or improved ease of operation and operator safety; in the reduction of waste; in the extension of livestock-keeping to people and areas where it has not been traditionally practised; and in the practice



J. HARTLEY/OXFAM

Tick control in camels.

of animal health care by livestock farmers.

Equipment for animal handling falls into the first category. Properly constructed races and crushes, the use of hurdles for sheep, or bull holders for the safe handling of horned cattle can all improve the productivity of labour and operator safety.

The reduction of wasted feed and water is best achieved by well-made feeders and watering devices. These will also reduce contamination of the feed and water and hence lower exposure to infection.

By using suitable housing, animals such as poultry and rabbits can be kept in areas where traditionally this has been difficult, perhaps because of predators. Also the use of reproductive aids, especially artificial insemination, has enabled farmers to own maybe only one female animal and to have it serviced by a premier quality sire, enabling the farmer to raise calves of high potential and hence remain competitive.

Specialist veterinary equipment for dosing animals or for the treatment of minor ailments, if made available to trained livestocker farmers, will enhance their animals' productivity. The most useful equipment is that which is adapted to fill a need rather than that which is transferred directly from intensive livestock systems to the less-intensive systems of poor livestock owners.

Alternatives

As has been said earlier, livestock husbandry requires few tools. Livestock is kept in developing countries without recourse to any of the gadgets used in intensive livestock keeping. These gadgets may not be relevant because of a differing scale of enterprise, the local climatic conditions or other circumstance. They may also require operating skills and technical back-up which is not available in developing countries. In addition, village-made equipment, particularly that for handling animals, may be most suited to the need.

Livestock husbandry may often be improved through education and training with no additional equipment. Improvements in nutrition, hygiene and health care will have significant effects. Provision of adequate water will enhance production, especially of milk. And breed improvements may raise productivity. New equipment is not essential to implement such changes.

Economics

The costs and benefits of using equipment in the keeping of livestock cannot be summarized in a general way. It is better to consider the desirability of livestock husbandry, which was well summarized by W.J.A. Payne in 1981:

> The rationale for increasing livestock production, despite the fact that animals are inevitably relatively inefficient converters of basic materials and energy into human food, is based on the following considerations:
>
> ● Livestock, particularly ruminants, can process forage and waste crop materials inedible by man into nutritionally desirable food products, many of high protein, mineral and vitamin content and including some of high calorific value.
>
> ● Approximately 40 per cent of the total land available in developing countries can be used only for some form of forage production and a further 30 per cent is scheduled as forest with some potential for the production of forage. In addition, some 12 per cent of the world's total population live in areas where food crops cannot be easily grown and where people depend entirely on the products obtained from ruminant livestock.
>
> ● Livestock provides, in addition to food products, additional outputs such as 'work energy', manure that can be used as fertilizer or a source of energy, and many other commodities useful to man, such as wool, hair and hides.
>
> ● Animal, plant and human life are ecologically interdependent and the establishment of agricultural systems in which livestock are integrated with field crops, tree crops, forestry and aquaculture are essential for the improvement of overall unit land area productivity.
>
> ● Livestock produces food products that add to the variety and nutritional quality of human diets and although it is possible for humans to exist without them, these foods are relished and sought after by the majority of mankind.

Well-fed cows produce more milk.

Given these overwhelming arguments for livestock production the benefits of maintaining or intensifying the production through the introduction of equipment will need to be assessed at the macro as well as the micro level. For example, in certain areas it may be deemed desirable to protect livestock production systems which are becoming uneconomic because of, say, the pressure on land, by introducing concentrated animal feeds, possibly subsidized, in order to maintain supplies and to protect incomes. The wastage of these feeds can be minimized by using the appropriate feeder, which will

benefit the individual farmer if the feeder is available at the right price.

Another example: if it is the policy of an administration to decentralize animal health care to individual farmers or farmers' groups then the provision of the correct equipment is essential. The pricing of inputs and outputs in this case will probably need adjusting in order to encourage take up of the health care facilities.

In other words, equipment introduction is likely to be effected more by a system of direct or hidden subsidies than just by extending knowledge about and availability of the equipment.

Impact

The use of certain types of livestock equipment can displace labour and can make possible large-scale intensive production systems. It is a matter for policy makers to decide whether extensive or intensive systems should be developed. The problems of intensive livestock raising, which is dependent on imported or centrally produced feeds, is well known. For example the crises for large-scale farmers in pig production in Jamaica or broiler production around Lima, Peru stem from this dependence. There is, thus, some advantage in protecting extensive, low-cost, systems, particularly at a time of rising input costs.

However if in the course of protecting these systems productivity, particularly in terms of livestock numbers, increases beyond the carrying capacity of the land, or beyond the capacity of the market, a different and very serious crisis can develop for poor livestock owners. It is therefore essential that any new inputs to the livestock husbandry of poor farmers are accompanied by carefully worked-out policies for controlling production.

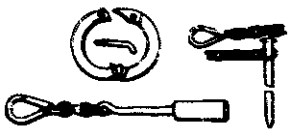
Special considerations

Education and training facilities for improving the livestock husbandry and related skills of poor livestock owners need to be emphasized. Given the large numbers of poor people who depend on livestock for part or all of their income, improvements in their skills and improvements in their knowledge of the inputs which are available to assist them could have considerable impact. Training and extension facilities for livestock farmers are available and more emphasis on providing these and providing the necessary new inputs at a reasonable cost should be given in the years to come.

Alastair Mews
School of Veterinary Science
University of Bristol

Reference

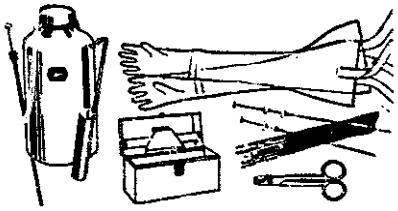
W.J.A. Payne (1981), 'The Desirability and Implications of Encouraging Intensive Animal Production Enterorises in Developing Countries' in *Intensive Animal Production in Developing countries, Occasional Publication No.4*, British Society of Animal Production. Edited by A.J. Smith and R.G. Gunn.



BULL-HANDLING EQUIPMENT

The handling equipment illustrated above includes a nose punch for punching the nasal septum through which the brass nose-ring is placed. To this may be attached the illustrated tethering and leading chains. These may be obtained from:

ANIMATICS LTD.
Enterprise Road
Busia Road Corner
P.O. Box 72011, Nairobi
KENYA



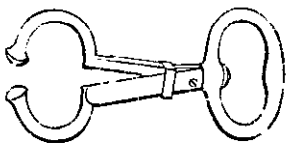
ARTIFICIAL INSEMINATION EQUIPMENT

When suitable equipment, support services, liquid nitrogen supply and trained personnel are available, A.I. may be used to introduce superior blood lines or to supplement the services provided by local bulls when these are in short supply.

The equipment pictured above includes: (from left to right) liquid nitrogen flask, straws, freezing racks, sheaths, insemination syringes and plastic gloves. Union Carbide flasks are available worldwide. Among many suppliers are:

ANIMATICS LTD.
Enterprise Road
Busia Road Corner
P.O. Box 72011, Nairobi
KENYA

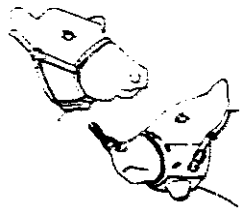
HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.



BULL HOLDER

A bull holder such as the one illustrated above is useful for grasping a bull or large steer by the nose for treatment or handling. This holder is supplied by:

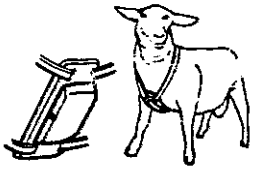
ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.



CATTLE-MATING HARNESS

These harnesses may be used on bulls to identify cows which have been served or on nymphomaniac cows to indicate those cows which are on heat. The two types illustrated above are supplied by:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.

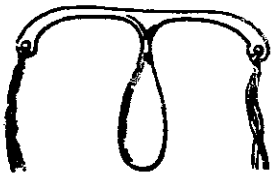


RAM HARNESS

Ram harnesses mark ewes which have been tupped. Ewes may then be grouped by expected lambing date. Suppliers include:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.

LORD INTERNATIONAL LTD.
P.O. Box 10149, 19 Mahana Road
Hamilton
NEW ZEALAND

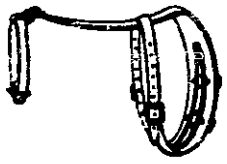


PLASTIC UTERI SUPPORT

This simple plastic support is designed to prevent uterine prolapse on ewes close to lambing. Supplied by:

ERVEN G. DE BOER BV
Westerplantage 1-7
9911 DC Leeuwarden
NETHERLANDS

DALTON SUPPLIES LTD.
Nettlebed
Henley-on-Thames RG9 5AB, Oxon
U.K.

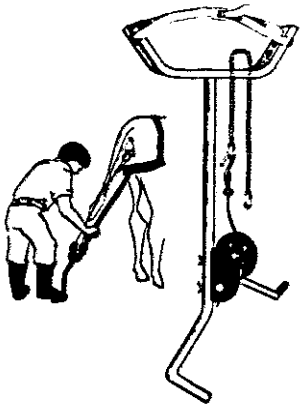


SHEEP TRUSS

Trusses of this type, designed to support the uterus and prevent prolapse, are available for cattle and sheep from:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.

RHEINTECHNIK
Welland & Kasper KG
Postfach 1170, Hellenpfad
5413 Bendorf/Rhein 1
W. GERMANY



CALVING AIDS

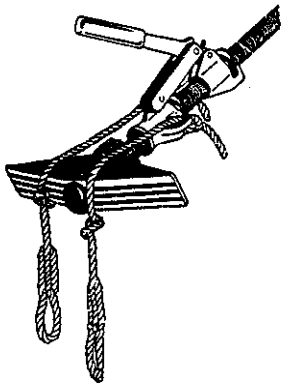
A range of calving aids are available to enable one person to exert a greater pull on the calf during a difficult calving. Each design consists essentially of a frame and winching system. Considerable damage to both cow and calf can be done if such aids are used by unskilled stockmen.

THE SAFEWAY CALF PULLER This has a foot stirrup to ensure that pulling is at the correct angle and tension to minimize injury to calf and cow (illustrated left).

COBURN CO. INC.
834E Milwaukee St., P.O. Box 147
Whitewater, Wis 53190
U.S.A.

THE GANNE CALVING TOOL This is a telescopic model supplied by:

GANNE, MATERIEL D'ELEVAGE
La Miouze, BPI, 63740 Gelles
FRANCE



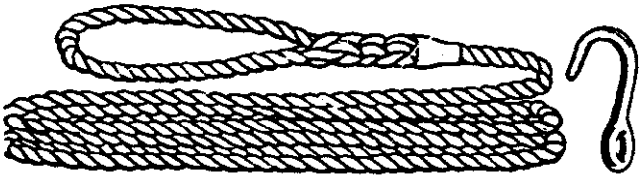
THE HK CALF SAVER

The principle of this calving aid (illustrated left) is that it should supplement the natural birth contractions. The head of this calving aid is placed close to the cow's vagina and the nylon cords from each side of the ratchet are attached to the calve's pasterns. There is also a quick release mechanism should complications arise.

RHEINTECHNIK
Welland & Kasper KG
Postfach 1170, Hellenpfad
5413 Bendorf/Rhein 1
W. GERMANY

THE EIDER BIRTH ASSISTOR This has twin, independently operated, pulling mechanisms. Supplied by:

EIDER-LANDGERÄTE KG
(Industriegebiet Weddingstedt)
Postfach 1349
2240 Heid/Holstein
W. GERMANY



CALVING ROPES, OBSTETRIC PULLEYS AND HOOKS

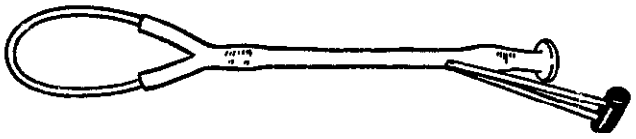
Strong nylon calving ropes, and other obstetrical aids may be required in the event of a difficult calving. Considerable damage can be done to both cow and calf if such aids are used by unskilled stockmen.

Among many suppliers of this type of equipment are:

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.

ERVEN G. DE BOER BV
Westerplantage 1-7
9911 DC Leeuwarden
NETHERLANDS

H. HALDENER
Postfach 2201-34
5650 Solingen 1
W. GERMANY



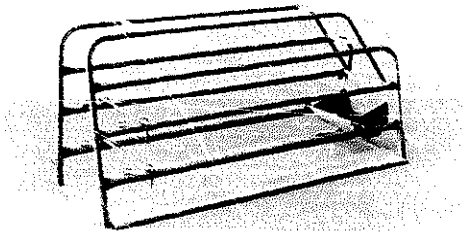
LAMBING INSTRUMENT

A lambing instrument of this type may be used in addition to ropes in a difficult lambing. The loop of the instrument is placed behind the ears of the lamb and tightened so the V rests under the jaw thus giving a hold on the head. The lamb may then be manipulated to the correct presentation and delivered. Instruments of this design are supplied by:

ERVEN G. DE BOER BV
Westerplantage 1-7
9911 DC Leeuwarden
NETHERLANDS

DALTON SUPPLIES LTD.
Nettlebed
Henley-on-Thames RG9 5AB, Oxon
U.K.

ALFRED COX SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.



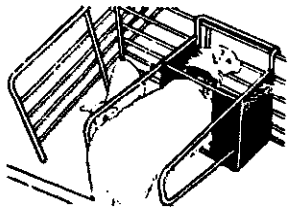
FARROWING CRATES

These are used to restrain the sow during the farrowing and lactation. They are designed to prevent the sow from crushing her young as she lies down. In a crate the piglets are safe at the sides or end where a lamp may be provided for warmth. The portable farrowing crate illustrated above is supplied by:

DAVID RITCHIE (IMPLEMENTS) LTD.
Whitehills, Forfar, DD8 3EE
Scotland
U.K.

Another manufacturer of farrowing crates is:

MARTING MFG
Washington Court House
OH 43160
U.S.A.



LAMB ADOPTERS

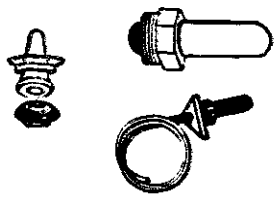
These are used to secure a ewe whilst she is persuaded to adopt a lamb. The adopter illustrated above may be set up in any pen attached to a hurdle. It is manufactured by:

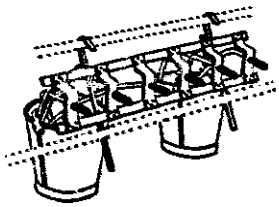
POLDENVALE LTD.
Industrial Estate, Williton
Taunton, Somerset TA4 4RF
U.K.

LAMB REVIVER

This is a simple bottle and tube which may be used to pass liquid food directly into the stomach of lambs which are too weak to suckle. One of many suppliers of this reviver is:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.





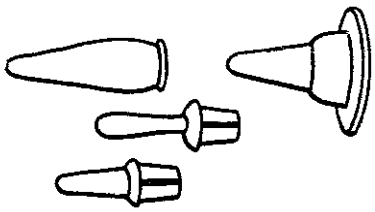
ARTIFICIAL MILK FEEDING OF CALVES

A variety of teats are manufactured to suit the different methods of feeding milk to calves. From left to right above: a valved teat used to wean calves onto bucket feeding; teats which attach to bucket (above) and bar feeders (below); and complete cafeteria systems for feeding a number of calves simultaneously. Suppliers of this equipment include:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.

C.H. DANA CO. INC.
Hyde Park, Vt. 05655
U.S.A.

EXCAL PRODUCTS
P.O. Box 82053, Highland Park
Howick, Auckland
NEW ZEALAND



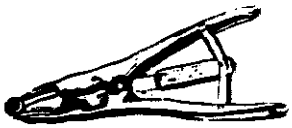
ARTIFICIAL MILK FEEDING OF LAMBS

As for calves, a range of teats and feeders is produced for feeding lambs when ewe's milk is unavailable or insufficient. The equipment used will depend on the number of lambs to be fed and the time available. Supplies may be obtained from:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR, U.K.

DALTON SUPPLIES LTD.
Nettlebed
Henley-on-Thames RG9 5AB, Oxon
U.K.

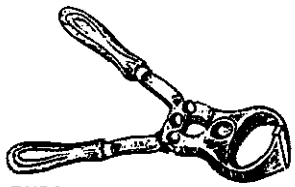
FIFARM NURSETTE LTD.
Cupar Muir, Cupar,
Fife, KY15 5SL
U.K.



ELASTRATOR

This castrating and tailing tool (illustrated above) may be used to castrate very young animals and to remove lambs' tails. The tool is used to apply elastic rings which cut off the circulation. This may be obtained from:

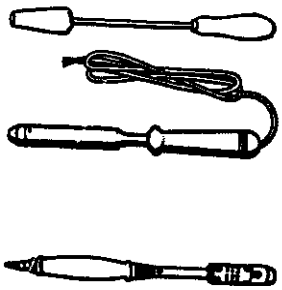
ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.



BURDIZZO BLOODLESS CASTRATOR

This castrator (illustrated above) may be used on animals of all ages up to maturity. It is used to crush the spermat cords. This equipment should be carefully serviced and adjusted so the correct separation of the jaws is maintained. Supplies from:

THE FARM-ACY (NZ) LTD.
399 Ferguson Street
P.O. Box 30, Palmerston North
NEW ZEALAND



DISBUDDING IRONS

The disbudding of calves with a hot iron prevents the growth of unwanted horns. Three types of iron are illustrated (left). From top to bottom: a simple hot iron, which must be heated in a fire; an electrically heated iron; and a butane gas iron. The calf should have a local anaesthetic before such irons are used. Disbudding irons may be obtained from:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.

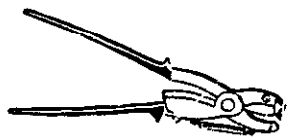
RHEINTECHNIK
Welland & Kaspar KG
Postfach 1170, Heilenpfad
5413 Bendorf/Rhein 1
W. GERMANY

ERVEN G. DE BOER, BV
Westerplantage 1-7
8911 DC Leeuwarden
NETHERLANDS

LAMB-TAILING IRONS

The Hayes lamb-tailing iron is a lightweight, easily handled iron which retains heat well for severing and cauterizing lambs' tails.

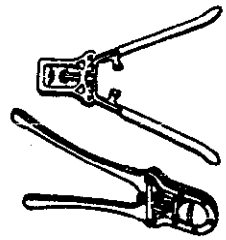
ERNEST HAYES (NZ) LTD.
789 Main South Road
P.O. Box 22042, Christchurch 4
NEW ZEALAND



MOUATT TAILER CASTRATOR

These tailing and castrating shears (illustrated above) for lambs and goats are designed to reduce blood loss to a minimum in a quick humane operation. It has teeth for pulling the testicles. Its steel blades are detachable for sharpening.

THE FARM-ACY (NZ) LTD.
399 Ferguson Street
P.O. Box 30, Palmerston North
NEW ZEALAND



DE-HORNING TOOLS

If de-horning is necessary, the tools illustrated (left) may be used. De-horning wire of 2- or 4-strand stainless steel may be used to saw through horn with the aid of special handles.

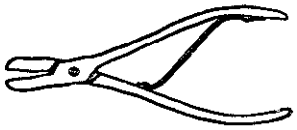
Alternatively, powerful shears with a guillotine-like action may be used.

Tools of this type are supplied by:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.

THE FARM-ACY (NZ) LTD.
399 Ferguson Street
P.O. Box 30, Palmerston North
NEW ZEALAND

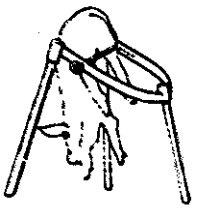
C.H. DANA CO. INC.
Hyde Park, Vt. 05655
U.S.A.



TOOTH-CUTTING FORCEPS

Tooth-cutting forceps such as those illustrated above are used to cut the sharp canine teeth of young piglets. These are available from:

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.



CASTRATION STOOL

This stool holds piglets up to eight weeks old safe and secure for castrating, ear tagging or ear notching, tattooing, tail docking, tooth cutting or veterinary inspection. This light-weight stool for a single operator is supplied by:

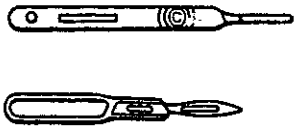
HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.

EMASCULATORS

Different designs of these bloodless castrators are supplied by:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.

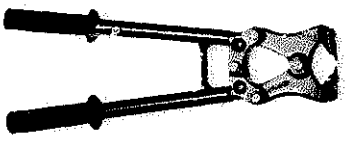
THE FARM-ACY (NZ) LTD.
399 Ferguson Street
P.O. Box 30, Palmerston North
NEW ZEALAND



SWANN-MORTON CASTRATING KNIVES

These castrating knives (illustrated above) are available from:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.



HOOF CUTTERS

Hoof cutters for cattle such as those illustrated are available with replacement blades. Blades can also be sharpened using a small flat stone. The better designs of hoof cutters allow adjustment of the gap between the blades. They are available from:

H. HAUPTNER
Postfach 2201-34
5650 Solingen 1
W. GERMANY

Similar hoof cutters for cattle are supplied by:

BROUWERS L.S.
Stalinrichtingen B.V.
Antwoordnummer 48
8900 VC Leeuwarden
NETHERLANDS

A wide range of farriers tools for horses' hooves are supplied by:

DIAMOND TOOL & HORSESHOE CO.
477 Madison Ave
New York, NY 10022
U.S.A.

FOOT ROT SHEARS

These are used to trim sheep's feet and remove infected parts. Shears of this type supplied by:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.

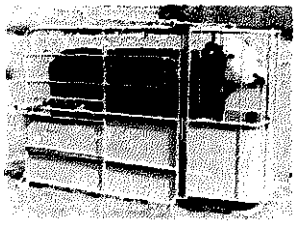
CEKA WORKS LTD.
Caernarvon Road, Pwllheli
Gwynedd LL53 5LH
U.K.

HOOF PARING KNIVES

These are supplied with a single or double edge and in right- and left-handed models by, among others:

H. HAUPTNER
Postfach 2201-34
5650 Solingen 1
W. GERMANY

SCHROCK HARNESS SHOP
55 Poole Road
West Union, OH 45693
U.S.A.



CATTLE CRUSHES AND HANDLING CRATES

Handling crates in which cattle may be held secure and immobile are valuable to simplify inspection and treatment. Some crates combine a weighing facility whilst others are especially designed for easy foot-trimming. Crushes are supplied by, among others:

DAVID RITCHIE (IMPLEMENTS) LTD.
Whitehills, Forfar, DD8 3EE
U.K.

LODDON LIVESTOCK EQUIPMENT LTD.
Loddon, Norwich
Norfolk, NR14 6JJ
U.K.

LEADING ENGINEERING
Bandari Road, Box 42131
Nairobi
KENYA

GANNE, MATERIEL D'ELEVAGE
La Mouze, BP1, 63470 Gelles
FRANCE

ERNEST HAYES (NZ) LTD.
788 Main South Road
P.O. Box 23042, Christchurch 4
NEW ZEALAND

DONALD PRESSES LTD.
P.O. Box 138, Masterton
NEW ZEALAND

SHEEP-HANDLING EQUIPMENT

THE GALLAGHER LAMB TAILING CHUTE is supplied by:

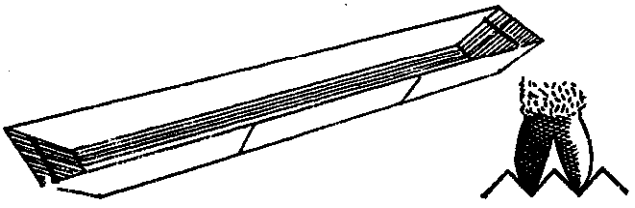
PYNE, GOULD, GUINNESS LTD.
178 Cashel Street
Christchurch
NEW ZEALAND

THE BEGG SHEEP HANDLER which is especially designed for treating foot rot is manufactured by:

G.N. BEGG ENGINEERING CO. LTD.
Drummond, Southland
NEW ZEALAND

THE DEMERE SHEEP HANDLER is a mobile crate in which a sheep is held on its back for treatment. Supplier:

FARMERS' GRAZCOS CO-OP
3 Spring Street, Sydney
N.S.W. 2000, AUSTRALIA



SHEEP FOOT BATH

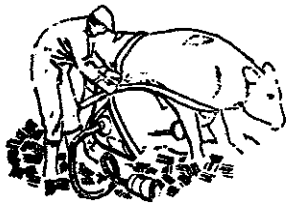
Foot baths containing a disinfectant and astringent solution may be used in the control of foot rot in sheep. The foot bath should be placed in a race and the sheep made to walk slowly through it.

THE ELTEX SHEEP FOOT BATH (illustrated above) has a ridged bottom to force the cloven hoof apart ensuring that all parts of the foot are treated.

GEORGE H. ELT LTD.
Elltex Works, Bromyard Road
Worcester WR2 5DN
U.K.

STAFIX LTD.
17 Eye Street, P.O. Box 232
Invercargill
NEW ZEALAND

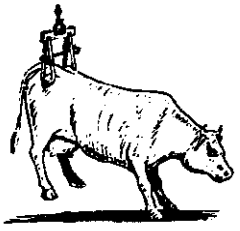
POLDENVALE
Industrial Estate, Williton
Taunton, Somerset TA4 4RF
U.K.



BOVI JAK COW LIFTERS

This cow lifter pictured above is a cube-shaped balloon which may be inflated under a recumbent cow lifting her into an upright position where she may be treated and her ability to stand on her own assessed.

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.

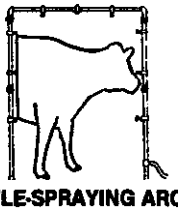


COW LIFTERS

Cow lifters which fit over the pin bones are supplied by:

ERNEST HAYES (NZ) LTD.
788 Main South Road
P.O. Box 23042, Christchurch 4
NEW ZEALAND

GANNE, MATERIEL D'ELEVAGE
La Mouze, BP1, 63740 Gelles
FRANCE



CATTLE-SPRAYING ARCH

This cattle-spraying equipment makes the application of insecticides onto large numbers of stock easy and accurate. It may be used with a 12-volt battery or PTO pump. This arch is supplied by:

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.

(See Section 5 for further spraying equipment.)

ELECTRICAL EGG INCUBATORS

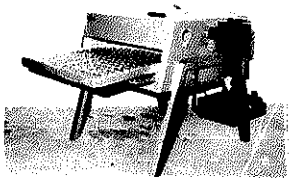
THE POLYHATCH (illustrated above) is a small (capacity 42 hens eggs) electrically-powered, still air incubator. It has electronic temperature control and automatic turning of all types of eggs. Developed and manufactured by:

BRINSEA PRODUCTS
West Brinsea Farm, Congresbury
Avon BS19 5JR
U.K.

CIRCULATING AIR INCUBATOR

THE TURN X incubator (illustrated above) is a solid state fan-powered circulating air incubator. This small incubator (capacity 18 chicken eggs) and the larger model the Roll-X are supplied by:

MARSH MFG. CO. INC.
717 1-T Patterson Drive
Garden Grove, California, 92641
U.S.A.



KEROSENE-OPERATED INCUBATORS

These incubators are valuable where electricity is not readily available. The Amuda kerosene-operated incubator pictured above has capacity for 150 eggs. It is supplied by:

RAJAN UNIVERSAL EXPORTS (MFRS.) PVT. LTD.
Post Bag 1[illegible], Madras 600 001
INDIA

Other suppliers of kerosene incubators include:

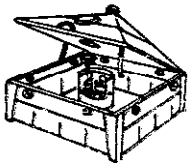
AGRICULTURAL MARKETING SERVICES INT. LTD.
Sandlow Green Farm
Holmes Chapel, Cheshire CW4 8AS
U.K.

WESTERN INCUBATORS LTD.
Springfield Road
Burnham-on-Crouch
Essex CM0 8TA
U.K.

BUTANE-OPERATED INCUBATOR

A mixed-power incubator, which can be operated on either electricity or butane gas or mixture of these two, is marketed by:

FAVOR
57-59 Boulevard Barbusse
54510 Tombaine
FRANCE



PARAFFIN CHICK BROODERS

The brooding phase is a very vulnerable one for the young bird. Additional heat may be provided at this stage by paraffin brooders. These can be run relatively cheaply where no electricity is available.

THE DELTON PYRAMID BROODER This brooder illustrated above comes in range of sizes with capacity for up to 200 day-old chicks.

GEORGE H. ELT. LTD.
Eltex Works, Bromyard Road
Worcester WR2 5DN
U.K.

Other kerosene brooders of much larger capacity are supplied by:

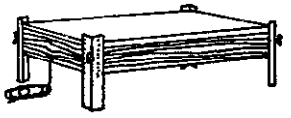
CASTYNE LTD.
18 Lady Lane Industrial Estate
Hadleigh, Ipswich IP7 6BQ
U.K.

LERNER & BAR ENGINEERING CO.
P.O. Box 11457, Tel Aviv 61113
ISRAEL

ELECTRIC CHICK BROODERS

THE ELECTRIC HEN This brooder (above right) has a completely enclosed low-watt element, and adjustable legs to suit the size of the chicks.

THE STAR CHICK HEATER This brooder is an infra-red heating lamp, both these brooders are supplied by:



GEORGE H. ELT. LTD.
Eltex Works, Bromyard Road
Worcester WR2 5DN
U.K.

Other types of electically-powered brooder are supplied by:

WESTERN INCUBATORS LTD.
Springfield Road
Burnham-on-Crouch
Essex CM0 8TA
U.K.

TAYLOR MADE SHEET METAL PRODUCTS LTD.
Box W 99, Waterfalls, Harare
ZIMBABWE

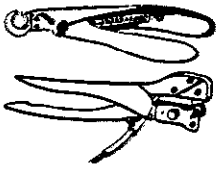
POULTRY VACCINATOR

THE VACCINAIR This (illustrated above) is a mains electric fan-assisted hand-held spray vaccinator for poultry. It is capable of spraying between 1,200 and 9,600 birds in 10 minutes according to stocking density.

Similar fan-assisted sprays can be used to keep down flies in animal houses and food preparation areas.

These sprayers are supplied by:

TURBAIR LTD.
Britannica House, Waltham Cross
Hertfordshire EN8 7DR
U.K.

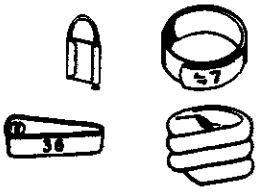


DE-BEAKERS

Manual and electrical de-beakers to prevent feather pecking and cannibalism available from:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.

DAYAL POULTRY APPLIANCES
WZ 16, Lajwanti Garden
New Jail Road, New Delhi 110 046
INDIA



POULTRY IDENTIFICATION

Wing tags and leg rings are used to identify poultry. Supplies available from:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.

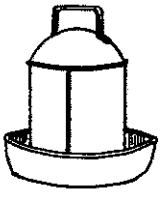
ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.

POULTRY KILLERS

This humane killer for poultry is bloodless and instantaneous. Supplies available from:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.

DALTON SUPPLIES LTD.
Nettlebed
Henley-on-Thames RG9 5AB, Oxon
U.K.

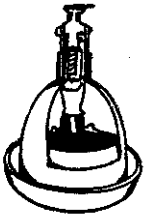


CHICK DRINKERS

Simple poultry drinkers of the type illustrated above are available from:

GEORGE H. ELT. LTD.
Eltex Works, Bromyard Road
Worcester WR2 5DN
U.K.

GANAL
Ca. Real de Madrid (S/N)
Apartado 17, Sills (Valencia)
SPAIN

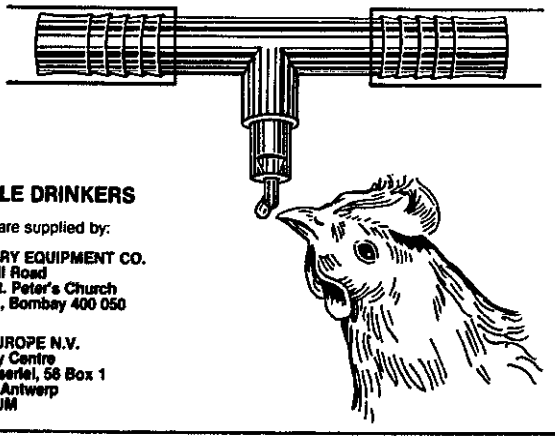


AUTOMATIC DRINKERS

These are available in a variety of designs from:

PLASSON PLASTIC PRODUCTS (1972)
DN Menashe 37, 605
ISRAEL

E. HOLZER INC.
120 Sylvan Avenue, P.O. Box 1250
Englewood Cliffs, NJ 07632
U.S.A.

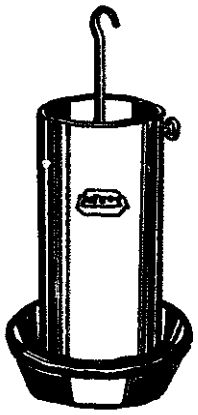


NIPPLE DRINKERS

These are supplied by:

POULTRY EQUIPMENT CO.
70A Hill Road
Opp. St. Peter's Church
Bandra, Bombay 400 050
INDIA

ASE EUROPE N.V.
Century Centre
de Keyserlei, 58 Box 1
B-2018 Antwerp
BELGIUM



TUBULAR POULTRY FEEDER

Hanging poultry feeders such as the one illustrated supplied by:

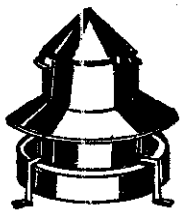
GEORGE H. ELT. LTD.
Eltex Works, Bromyard Road
Worcester WR2 5DN
U.K.

C.H. DANA CO. INC.
Hyde Park, Vt. 05655
U.S.A.

TAYLOR MADE SHEET METAL PRODUCTS LTD.
Box W 99, Waterfalls, Harare
ZIMBABWE

PAL, SA
3 rue de Riez, BP 35
59112 Annoeutlin
FRANCE

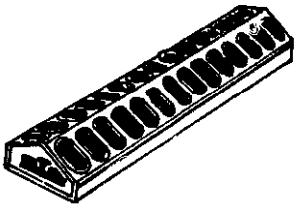
MOHINDER & CO. ALLIED INDUSTRIES
Kurali, Distt. Ropar, Punjab
INDIA



ALL-WEATHER FEED HOPPERS

All-weather feed hoppers are available for outdoor use. The hopper keeps water and vermin out. The hopper illustrated is supplied by:

GEORGE H. ELT. LTD.
Eltex Works, Bromyard Road
Worcester WR2 5DN
U.K.

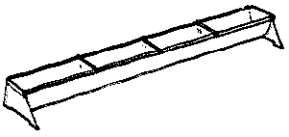


CHICK FEEDERS

Small chick-feeding troughs are supplied by among others:

GEORGE H. ELT. LTD.
Eltex Works, Bromyard Road
Worcester WR2 5DN
U.K.

MOHINDER & CO. ALLIED INDUSTRIES
Kurali, Distt. Ropar, Punjab
INDIA

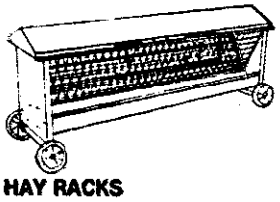


TROUGHS

Simple troughs in sizes to suit all farm species are sold by:

GEORGE H. ELT. LTD.
Eltex Works, Bromyard Road
Worcester WR2 5DN
U.K.

STEINZEUG, GmbH
Max-Planck Str 6
Postfach 40 0560
5000 Köln 40 (Marsdorf)
W. GERMANY

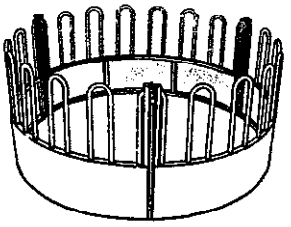


HAY RACKS

Small hay racks as illustrated above, which prevent fodder being wasted, are supplied by:

POLDENVALE LTD.
Industrial Estate, Williton
Taunton, Somerset TA4 4RF
U.K.

ETS LOUIS TELLIER
66 rue de Laon
Athies-sous-Laon
02000 Laon
FRANCE



CIRCULAR FEEDERS

Use of circular feeders such as the one illustrated above can reduce feed wastage and bullying. These feeders come in semi-circular sections making them portable and ideal for feeding cattle in many locations. In the circular construction they are free-standing and highly robust. Alternatively semi-circular sections may be used backed by a fence. Among many manufacturers of this type of feed barrier are:

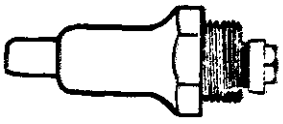
POLDENVALE LTD.
Industrial Estate, Williton
Taunton, Somerset TA4 4RF
U.K.

H.J. URRY & SONS LTD.
Alveley, Bridgnorth
Salop WV15 6HN
U.K.

F. KLUCZNIK & SON LTD.
Riverside Works
Macclesfield Road
Leek, Staffs. ST13 8LB
U.K.

Circular feeders designed for feeding big round bales are available from:

DAVID RITCHIE (IMPLEMENTS) LTD.
Whitehills, Forfar
Angus DD8 3EE
U.K.



NIPPLE DRINKERS

Bite and press-operated nipple drinkers for pigs and calves may be obtained from:

AZA INTERNATIONAL S.R.L.
Via Spluga 52
22062 Cernusco Lombardone, (Como)
ITALY

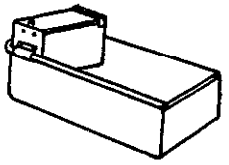
MARTIN GLÖGGLER
Postfach 1444, Kranzweg 2
7910 Neu-Ulm/Schwaighofen
W. GERMANY

AUTOMATIC BOWL DRINKERS

These are available in many specifications for all species from, among many manufacturers:

LA BUVETTA
15 rue de L'Arquebuse
08000 Charleville-Mézières
FRANCE

GORENJE-MUTA
62366 Muta
YUGOSLAVIA

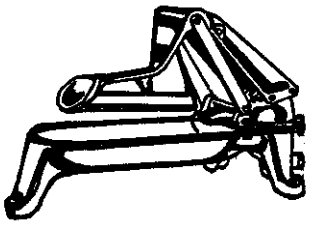


AUTOMATIC RE-FILLING TROUGHS

This type of trough which may be used when piped water is available is supplied by:

GEORGE H. ELT. LTD.
Eltex Works, Bromyard Road
Worcester WR2 5DN
U.K.

ETS ALBERT S.A.
Rue de Bellefontaine
6960 Bievre
BELGIUM



PASTURE PUMPS

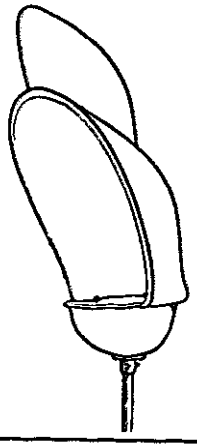
THE SUEVIA PASTURE PUMP (illustrated above) This is a diaphragm pump capable of drawing water under simple suction from a depth of up to 9 metres. The pump is operated by a system of levers making it easy for man or animal to draw water into a large cast-iron basin. The mounting of this pump is made of synthetic material to remove any chance of corrosion.

SUEVIA HAIGES GmbH & CO.
Postfach 1108, Max-Eyth-Straße
7125 Kirchheim/Neckar
W. GERMANY

Pasture pumps of a similar design which may be used for pumping water from shallow springs or water courses are also supplied by:

EIDER-LANDGERÄTE KG
(Industriegebiet Weddingstedt)
Postfach 1349
2240 Heid/Holstein
W. GERMANY

RENSON ET CIE
BP 23, 59550 Landrecies
FRANCE



MINERAL DISPENSERS

THE ROTATING CATTLE DROVER This salt lick (illustrated left) is a fibre-glass dispenser capable of holding 30kg of salt. It has a weather vane and wind shield which protect the minerals from the rain. It is easy to carry and can be set up anywhere to give stock constant access to minerals.

MECÂNICA RITTER S/A
Máquinas e Imp Agricolas
Rua Catuipe s/no, CP 201
Santo Angelo RS
BRAZIL

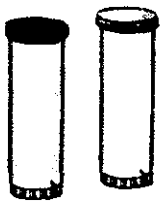
THE 'NO-TIP' MINERAL FEEDER This is of similar design. The reinforced rubber tube of this dispenser is held in a steel frame and protected by a polyethylene hood.

C.H. DANA CO. INC.
Hyde Park, Vt. 05655
U.S.A.

SALT LICK STAND

The two-in-one salt lick stand and mineral holder illustrated above is manufactured in strong polypropylene and supplied by:

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.

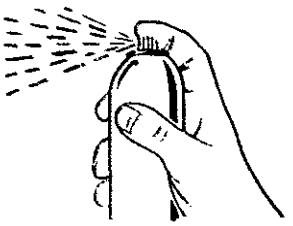


MARKING STICKS

Marking sticks are available in a range of colours. These pocket-sized markers are wax crayons protected within a metal or plastic tube.

The sticks illustrated above are supplied by:

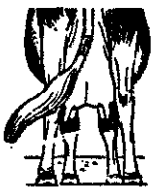
ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.



AEROSOL SPRAY MARKERS

Special semi-permanent spray paints are available for livestock identification. These come in a range of colours which do not irreversibly mark the hide or fleece. Supplies are available from:

H. HAUPTNER
Postfach 2201-34
5650 Solingen 1
W. GERMANY



TAIL TAPE

Coloured and numbered adhesive tail-tape for temporary identification is supplied by:

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.

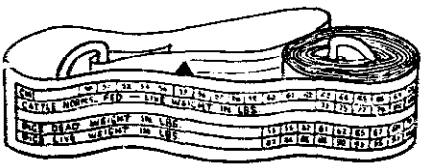
DALTON SUPPLIES LTD.
Nettlebed
Henley-on-Thames RG9 5AB, Oxon
U.K.

SUSPENDED SPRING BALANCE WEIGHERS

These balances which are useful for weighing small animals are supplied by:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.

ERVEN G. DE BOER, BV
Westerplantage 1-7
8911 DC Leeuwarden
NETHERLANDS



WEIGH BAND

Weigh bands make it possible to assess the approximate live or dead weights of cattle and pigs without the use of scales, by measuring the animal's girth. The weighband is placed around the animal's girth. Its weight may then be read directly off the band against the linear measurement of its girth. Weigh bands are supplied by:

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.

COBURN CO. INC.
834E Milwaukee St
P.O. B 147, Whitewater, Wis 53190
U.S.A.

DALTON SUPPLIES LTD.
Nettlebed
Henley-on-Thames RG9 5AB, Oxon
U.K.

WEIGHING CRATES

Weighing crates may rely on mechanical, hydraulic or electronic means of measurement. Suppliers include:

DAVID RITCHIE (IMPLEMENTS) LTD.
Whitehills, Forfar, DD8 3EE, U.K.

LESLIE P. MORRIS LTD.
Dale Street, Craven Arms
Salop SY7 9NY, U.K.

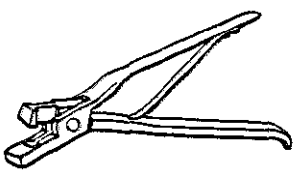
FARMEX AGRARISCHE BOUWSYSTEMEN
Loswal 12, Postbus 168
9200 AD Drachten
NETHERLANDS

BASCULAS LABRIOLA S.A.
Gallo 1560 a/11, de September Y Deroul (1828), Badfield, Buenos Aires
ARGENTINA

MARTING MFG.
Washington Court House
OH 43160, U.S.A.

J.W. BAUMANN
Postfach 60
6591 Thiersheim
W. GERMANY

TAURUS SPRAYING SYSTEMS (PVT.) LTD.
20 Harrow Road, Msasa, Harare
P.O. Box AY 18, Amby
ZIMBABWE

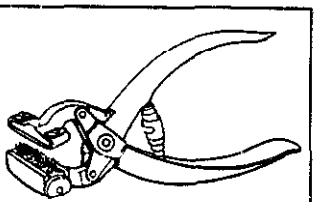


EAR MARKING PLIERS

These pliers, which are used to make identifying notches, are supplied by:

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.

DECKER MANUFACTURING COMPANY
312 Blondeau, Keokuk
Iowa 52632
U.S.A.

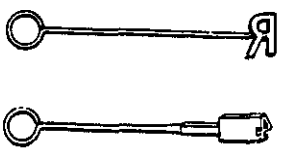


TATTOOING FORCEPS

Tattooing forceps for ear-marking rabbits, piglets, poultry, calves and lambs may be obtained from:

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.

THE FARM-ACY (NZ) LTD.
399 Ferguson Street
P.O. Box 30, Palmerston North
NEW ZEALAND

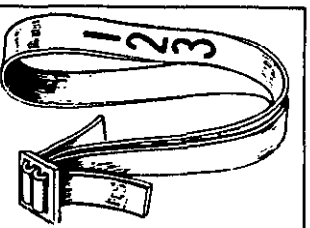


BRANDING IRON

Branding irons in letters and numerals are supported by:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.

H. HAUPTNER
Postfach 2201-34
5650 Solingen 1
W. GERMANY

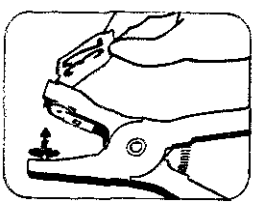


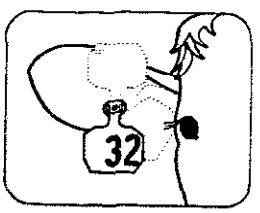
NECK STRAPS

Plastic neck straps with number and colour coding are supplied by:

BOCK'S CATTLE IDENTI. CO.
3101 Cedar Avenue, Box 614T
Mattoon, Illinois 61938
U.S.A.

ERVEN G. DE BOER, BV
Westerplantage 1-7
8911 DC Leeuwarden
NETHERLANDS





PLASTIC EAR TAGS

Two-piece plastic ear tags such as:

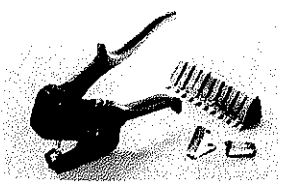
THE HERDSMAN tag (illustrated left) are supplied by:

TEMPLE TAG DIV.
Zoecon Industries Inc.
P.O. Box 369 Temple, Texas 76501
U.S.A.

ASE EUROPE N.V.
Century Centre
de Keyserlei 58, Box 1
B-2018 Antwerp
BELGIUM

A large flexible single piece tag, the Ritchey Ear Tag, is supplied by:

TALBOT PLASTICS
9-13 Wise Street, Christchurch
NEW ZEALAND



EAR TAGGER

Taggers for inserting small stainless identification tags are available from:

H. HAUPTNER
Postfach 2201-34
5650 Solingen 1
W. GERMANY

H.A. MOYER MFR.
Box 174 Salina Station
Syracuse, New York 13206-0174
U.S.A.

ANKLE STRAPS

Reusable ankle straps for easy identification of dairy animals are available from:

ALLFLEX INTERNATIONAL LTD.
Private Bag 931, Tremaine Avenue
Palmerston North
NEW ZEALAND

COBURN CO. INC.
834E Milwaukee St.
P.O. B 147, Whitewater
Wis 53190
U.S.A.

VETERINARY KIT FOR ANIMAL HEALTH AUXILIARIES

The equipment illustrated on this page might be used by an experienced Animal Health Auxiliary (under the supervision of a Veterinarian) in the prevention, diagnosis and treatment of simpler ailments. Preventive treatment might include the use of vaccines or serums given by injection.

In diagnosis, the animal's temperature, heart and respiratory rates are valuable signs in addition to visual symptoms. Even though an A.H.A. can do little more than recognise the more familiar symptoms of disease, he plays an important part in routine collection of smears and specimens and in post-mortem examinations.

An A.H.A. is able to administer drugs and medicines prescribed by a Vet. He can repair wounds and assist the Vet with more complex treatments.

The following are general suppliers of veterinary equipment:

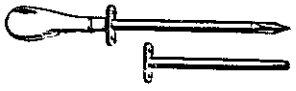
H. HAUPTNER
Postfach 2201-34
5650 Solingen 1
W. GERMANY

ARNOLDS VETERINARY PRODUCTS LTD.
14 Tessa Road, Richfield Ave.
Reading, Berks. RG1 8NF
U.K.

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.

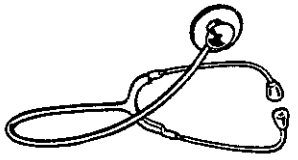
RHEINTECHNIK
Weiland & Kasper KG
Postfach 1170, Hellenpfad
5413 Bendorf/Rhein 1
W. GERMANY

VETERINARY DRUG CO.
129-135 Lawrence Street
York YO1 3EG
U.K.



TROCAR AND CANNULA

A trocar and cannula are used in extreme cases of bloat in ruminant animals. In cases where bloat cannot be relieved by less violent methods such as drenching with liquid paraffin or use of a stomach tube, the rumen must be punctured through the left flank of the animal to release the trapped gas.



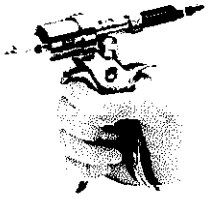
STETHOSCOPE

A stethoscope may be used by a skilled person to listen to the heart and lungs of an animal thereby judging its health and condition.

STERILIZABLE SYRINGES

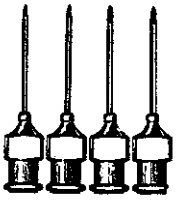
Simple sterilizable syringes are manufactured in a range of sizes and with different needle mountings. They may be made of nylon, glass and metal or all metal.

THE EUROPLEX SYRINGE (illustrated above) will withstand wet heat up to 130°C or dry heat up to 160°C. Syringes of this type are suitable for all types of injection.



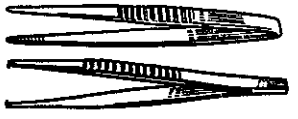
MULTI-DOSE SYRINGES

The multi-dose syringe may be useful if a large number of injections are to be given. Two types of multi-dose syringe are available. The first, an example of which is pictured above, does not refill itself but will give a number of repeat doses by pressure on the trigger until the syringe is empty. The second type is refilled after each dose from a suspended canister.



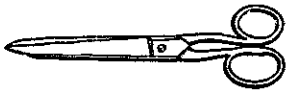
SYRINGE NEEDLES

Needles are available for intravenous, hypodermic and intramuscular injection. Different methods of injection and size of animal demand a range of needles for different tasks. Whenever possible a freshly sterilized needle should be used for each animal to avoid transferring infection from one animal to another. The luer lock needles (illustrated) lock onto special syringes. This prevents needles being dropped and lost.



FORCEPS

Forceps are essential tools for precise, delicate tasks. A variety of shapes and design are manufactured to suit each task. For example, pointed splinter forceps, tissue forceps with teeth and angular dressing forceps. Forceps should be made of stainless steel.

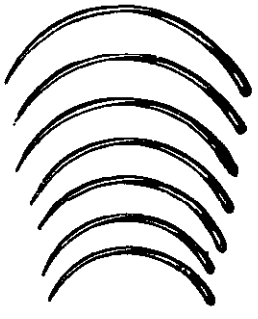


SCISSORS

Scissors are required for a variety of tasks and hence a variety of designs are available. Dressing, dissecting and clipping all require sharp scissors. Dressing scissors should be of stainless steel and be kept clean.

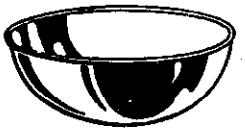
SCALPEL AND BLADES

Scalpels will be necessary if any dissection or surgery is to be undertaken. The blades are renewable and can be obtained in sterile packs in a range of designs and sizes.



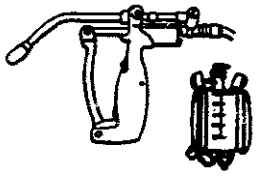
SUTURE NEEDLES

These are supplied in a range of sizes in curved and half curved shapes and with triangular or round points. They are made from stainless steel.



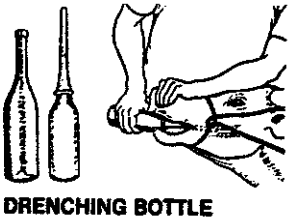
INSTRUMENT DISH

A stainless steel instrument dish such as the one illustrated above provides a clean surface on which to put sterile instruments.



DRENCHING GUNS

Automatic refilling drenching guns such as the one illustrated above are invaluable when a large number of animals are drenched routinely. The gun which may be adjusted to dispense the desired dose refills automatically from a canister which may be carried on the back or hung over a race.



DRENCHING BOTTLE

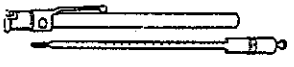
A simple drenching bottle is the most straightforward method of administering liquid medicine to animals. It enables the medicine to be poured directly into the animal's mouth.

Drenching must be performed carefully to avoid fluid passing into the animal's lungs. To this end the animal's head is raised in line with the neck and the dose given slowly with regular pauses to enable the animal to swallow and breathe.

BALLING GUN

Balling guns are made in a range of sizes and types to administer pills or medicinal bullets to animals by placing them at the back of the throat.

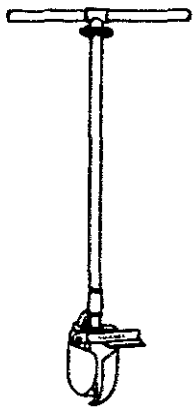
The gun illustrated is specially designed to administer cobalt bullets to sheep. It is made of heavy gauge brass, is nickel plated, and has a rubber mouthpiece. Balling guns are more difficult to use in pigs because the shape of the pig's throat tends to trap the bolus.



VETERINARY THERMOMETER

An abnormal body temperature is a good indication of a sick animal. Thermometers are available calibrated in Fahrenheit and Centigrade.

HOBDAY'S VETERINARY THERMOMETER (illustrated above) is marked with the normal temperature of the more common farm species: (Cow, Pig, Horse) as a reference. It should be noted however that normal temperatures will vary between healthy animals due to climate, oestrus, physical activity and food intake.



EARTH AUGERS

The earth auger (pictured left) has cutting edges of high carbon steel. It is adjustable to bore holes of 150mm to 400mm diameter, for the purpose of preparing fence post holes.

KUMAON NURSERY
Ramnagar — 244715
Nainital, U.P.
INDIA

Earth augers are also supplied by:

GUTHRIE TRADING PTY.
240 Currie Street
Adelaide, SA 5001
AUSTRALIA

SEYMOUR MAN. CO. INC.
500 North Broadway, P.O. Box 248
Seymour, Indiana 47274
U.S.A.

MAWROB CO. (ENGINEERS) LTD.
121a/125a Sefton Street
Southport, Merseyside PR8 5DR
U.K.

POST HOLE DIGGERS

Diggers such as the one illustrated left are available from:

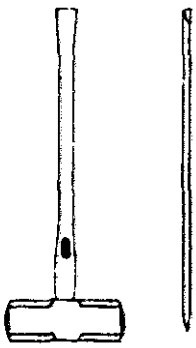
DRIVALL LTD.
Churchbridge Works, Cannock
Staffordshire WS11 3JP
U.K.

KELLER MFG. CO. INC.
4324-36 Fyler Avenue
St. Louis, Mis 63116
U.S.A.

LYSBRO FABRIKER A-S
P.O. Box 219, DK 8600 Silkeborg
DENMARK

TRAMONTINA SA
P.O. Box 1
95185 Carlos Barbosa RS
BRAZIL

IDEALSPATEN BREDT & CO. KG
Goethestr 27, Postfach 265
5804 Herdecke
W. GERMANY



SLEDGE HAMMER AND CROWBAR

Tools of this type for driving posts and making holes are supplied by:

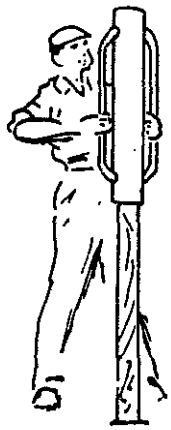
BULLDOG TOOLS
Clarington Forge, Wigan
Lancashire WN1 3DD
U.K.

LEON CLEMENT & CIE
Corravillers
70310 Faucogney (Haute-Saône)
FRANCE

BULAWAYO STEEL PRODUCTS
8 Ironbridge Road, Donnington
P.O. Box 1603, Bulawayo
ZIMBABWE

TROPIC
B.P. 706, Douala
CAMEROON

EDELMIRO VAZQUEZ Y HNO., S.L.
Apartado 84, Avenida de Vigo 126
Pontevedra
SPAIN



POST DRIVER

This implement consists of a heavy tube, with its upper end closed, and two handles. The tube is placed over the post, and used instead of a mallet or sledge hammer. The implement is easy to use and does not damage the heads of the posts.

Post drivers of this design are available from:

DRIVALL LTD.
Churchbridge Works, Cannock
Staffordshire WS11 3JP
U.K.

MAWROB CO. (ENGINEERS) LTD.
121a/125a Sefton Street
Southport, Merseyside PR8 5DR
U.K.

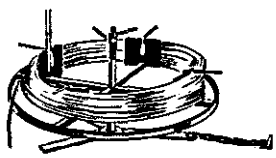
DONALD PRESSES LTD.
P.O. Box 138, Masterton
NEW ZEALAND

FENCING PLIERS

This multipurpose fencing tool acts as a plier, hammer, wire cutter and strainer, and removes staples and nails. It is supplied by:

DALTON SUPPLIES LTD.
Nettlebed
Henley-on-Thames RG9 5AB, Oxon
U.K.

SELF SUFFICIENCY AND SMALLHOLDING SUPPLIES
The Old Palace, Priory Road
Wells, Somerset BA5 1SY
U.K.



WIRE DISPENSER

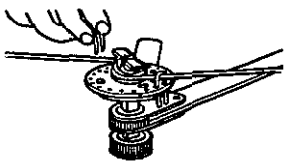
Fencing wire may be dispensed from reels such as the one illustrated above. This dispenser is suitable for running out all sizes of wire. It is secured in the ground by means of a central stake and has a spring tension brake.

ERNEST HAYES (NZ) LTD.
789 Main South Road
P.O. Box 23042, Christchurch 4
NEW ZEALAND

WIRE STRAINERS

Chain wire strainers with wire splicing tool of the type illustrated above are available from:

ELIZA TINSLEY & CO. LTD.
P.O. Box 35, Reddal Hill Road
Cradley Heath, Warley
W. Midlands B64 5JF
U.K.

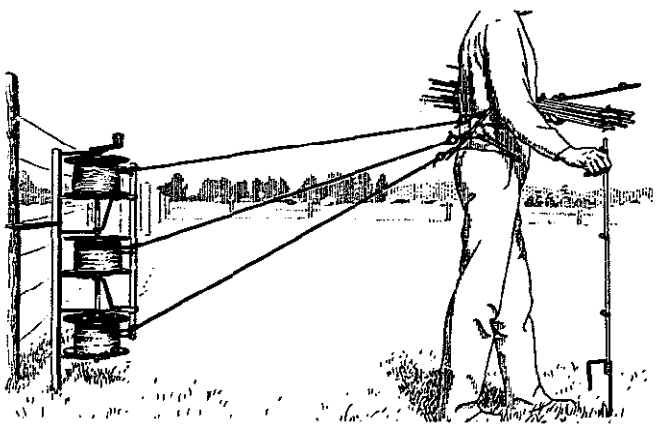


WIRE TIGHTENER

Tighteners of the type illustrated above which are used with detachable handles may be obtained from:

RANCHMAN INDUSTRIES LTD.
P.O. Box 8321, Riccarton
Christchurch
NEW ZEALAND

WELBY-EZY-WAY PRODUCTS LTD.
25 Morgan Street, Newmarket
Auckland
NEW ZEALAND



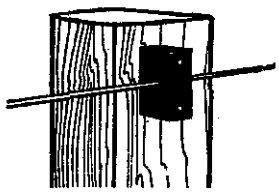
ELECTRIC FENCING

Where mains or battery electricity supply is available electric fencing may be used as a simple temporary means of stock control. The simplest of electric fences consists of a reel of wire, a series of insulated posts and a battery fencing unit to supply charge.

THE MULTI-REEL SYSTEM This system (illustrated above) is a more sophisticated arrangement designed to increase speed and convenience in strip grazing systems.

PRECISION ELECTRONICS LTD.
P.O. Box 9188
Hamilton
NEW ZEALAND

HURRICAN WIRE PRODUCTS LTD.
P.O. Box 51094, Auckland
NEW ZEALAND

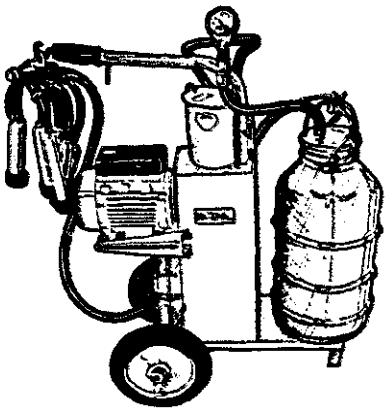


ELECTRIC FENCE INSULATORS

A variety of designs of insulator are available from:

ARC-RITE LTD.
P.O. Box 36, Marton
NEW ZEALAND

REESE'S SPECIAL A/S
Snerlevej 3, Industri Syd
6100 Haderslev Postbus 80
DENMARK



SMALL TROLLEY-MOUNTED MILKING MACHINES

These are supplied by a number of manufacturers. Essentially they all consist of a vacuum pump, a power unit, a milking unit, milk can and pulsation system.

THE NATIONAL MILKER This (illustrated above) is available in models for cows, goats, sheep, buffalo, camels and reindeer. Its electric motor drives a piston-type vacuum pump. The milker can be supplied with one or two clusters and may be fitted with a petrol engine. Available through:

GLIDDON & SQUIRE
Pottington Road, Barnstaple
Devon EX31 1JH
U.K.

SELF SUFFICIENCY AND SMALLHOLDING SUPPLIES
The Old Palace, Priory Road
Wells, Somerset BA5 1SY
U.K.

THE CARRELLO This is a complete milking system which requires no additional equipment for milking in several sheds. It is supplied by:

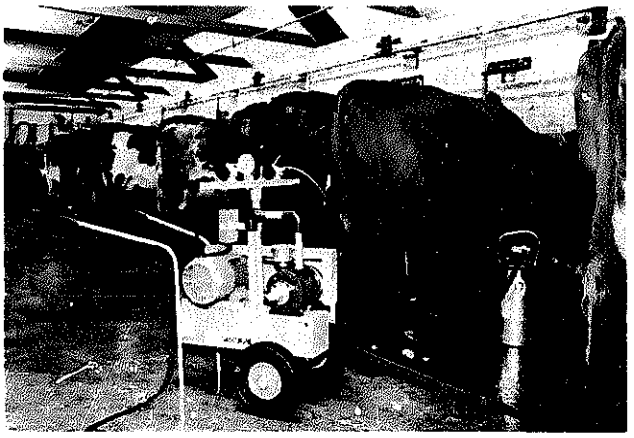
ALFA-LAVAL AB
P.O. Box 1008, 221 03 Lund
SWEDEN

SINGLE AND DOUBLE MACHINES These are capable of milking one and two cows or buffalo respectively and are supplied by:

JYOTI LTD.
Bombay Shopping Centre
R.C. Dutt Road, Vadodara 390 005
INDIA

TEK TARIM MAKINALARI
Ticaret ve Sanayi A.S.
Akhisar Cad. No. 146, Manisa
TURKEY

MACESA
Camino de Iturrigorri 3
Bilbao 2
SPAIN



PORTABLE MILKING MACHINES

These are self-contained mobile units which may be used in conjunction with a bucket plant to bring the benefits of machine milking to small dairy farmers. These machines may be trolley mounted or may have a carrying handle.

THE MINI LAC BUCKET MILKER This may be powered by either petrol engine or electric motor to enable two cows to be milked simultaneously (illustrated above).

GASCOIGNE MILKING EQUIPMENT LTD.
Berkeley Avenue, Reading
Berkshire RG1 6JW
U.K.

SMALL PORTABLE MILKING MACHINES are supplied by:

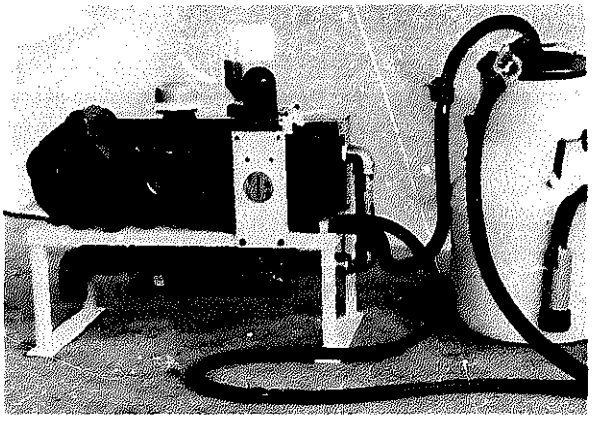
OTENZ GROUP
P.O. Box 209, Otorohanga
NEW ZEALAND

PULSATIONLESS MILKING MACHINES

THE HOSIER MOTOLAC This is a portable low vacuum, pulsationless milking machine suitable for two cows or four goats. The power unit is a ½hp electric motor with a dry vacuum pump and silencer. These machines are fitted with special neoprene, one-piece teat cups which have been designed for use under continuous low vacuum, making pulsation unnecessary. This ensures maximum milk extraction in a minimum time.

A HAND OPERATED VACUUM PUMP is produced for use with pulsationless machines where electric or motorised power is not available. This pump is a replacement for the WILICOM produced by Technolac in Argentina.
Available from:

HOSIER FARMING SYSTEMS
Collingbourne Ducis
Nr. Marlborough, Wiltshire SN8 3EH
U.K.



SMALL VACUUM PUMPS

Small vacuum pumps which supply adequate vacuum for two or more clusters may be used directly with a bucket machine or via an air line.

THE MINIMILKER This mini system (illustrated above) can be powered by electric or hydraulic motor or petrol engine.

NATIONAL DAIRY ASSOCIATION
P.O. Box 1001, 69/71 Beach Road
Auckland
NEW ZEALAND

SMALL VACUUM PUMPS These may be obtained from most manufacturers of dairying equipment, including the following.

ALFA-LAVAL AB
P.O. Box 1008, 221 03 Lund
SWEDEN

NU PULSE (NZ) LTD.
P.O. Box 5385
Keddell Street, Hamilton
NEW ZEALAND

R.J. FULLWOOD AND BLAND LTD.
Fullwood Works
Ellesmere, Salop SY12 9DG
U.K.

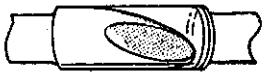
MACESA
Camino de Iturrigorri 3,
Bilbao 2
SPAIN

WESTFALIA SEPARATOR AG
4740 Oelde, Westfalen
W. GERMANY

JUAN B. BOSIO S.R.L.
Chubut 772, 2535 El Trébol (Sta. Fe)
ARGENTINA

A machine manufactured by the Shanghai Dairy Machinery Factory is available through:

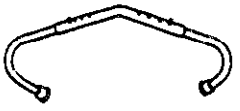
CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing
CHINA



MASTITIS DETECTOR

This screen (top left) for in-line detection of mastitis clots is supplied by:

HARRIS ASSOCIATES
Crab Hill Farm, South Nutfield
Redhill, Surrey RH1 5NR
U.K.



KICK BAR

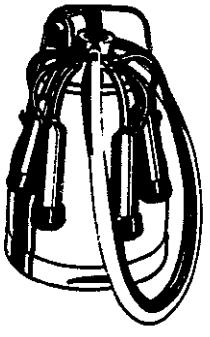
These may be used in place of hobbles to immobilize a cow's hind leg, (left, middle).

ARNOLDS VETERINARY PRODUCTS LTD.
14 Tesse Road, Richfield Ave.
Reading, Berks. RG1 8NF
U.K.

COW TIE

One of many manufacturers of chain link cow ties (bottom left) is:

CEAF
s.n.c. F.lli Siletti, 24034 Cisano
Bergamasco
ITALY



BUCKET MILKING MACHINES

These machines which are used in conjunction with small vacuum pumps consist of a bucket or churn of stainless steel, aluminium or polythene, which has a sealed lid. To this are attached the pulsator and cluster. Machines of this type are supplied by among many:

ELECREM
49 bvd. de la Republique
92100 Boulogne Billancourt
FRANCE

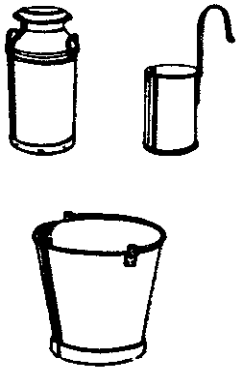
ALFA-LAVAL AB
P.O. Box 1008, 221 03 Lund
SWEDEN

COPELEVAGE
Av. de Hogger
Z.A. de Courtaboeuf, Les Ulis
FRANCE

MILK STRAINERS AND FILTERS

A range of strainers and filters are available to remove foreign material from milk, extending from filter paper to wire gauze. Equipment of this type is manufactured by:

J.J. BLOW LTD.
Oldfield Works, Chatsworth Road
Chesterfield S40 2DJ
U.K.



MILK-HOLDING VESSELS

Stainless steel milk churns, buckets and cream setting pans may be obtained from:

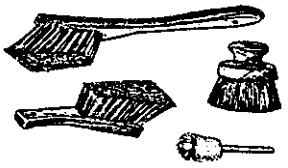
ANIMATICS LTD.
Enterprise Road
Busia Road Corner
P.O. Box 72011, Nairobi
KENYA

Stainless milk churns are manufactured by Kum Sung Co. Ltd. and are available through:

KOREA TRADE PROMOTION CORPORATION
C.P.O. Box 1621, Seoul
KOREA

A milk churn made of high density polyethylene is available from:

JACTO, MÁQUINAS AGRÍCOLAS S/A
Rua Dr. Luiz Miranda 5 1650
Caixa Postal 35, Pompéia S.P.
BRAZIL

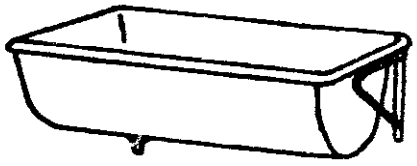


DAIRY BRUSHES AND HYGIENE EQUIPMENT

A range of dairy hygiene equipment is supplied by:

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.

SELF SUFFICIENCY AND SMALLHOLDING SUPPLIES
The Old Palace, Priory Road
Wells, Somerset BA5 1SY
U.K.



CHURN WASHING TROUGHS

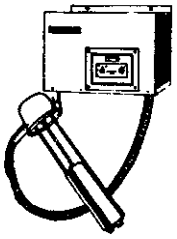
Troughs for washing churns and other dairy equipment are supplied in glass fibre, glass-reinforced polyester and galvanized steel from:

COPELEVAGE
Av. Du Hogger
Z.A. de Courtaboeuf, Les Ulis
FRANCE

CHEMO-WERK, GmbH
Postfach 5160
7056 Weilstadt-Strümpfelbach
W. GERMANY

EIDER-LANDGERÄTE KG
Postfach 1349
2240 Heide/Holstein
W. GERMANY

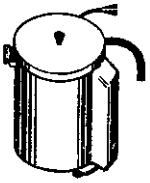
GEORGE H. ELT. LTD.
Eltex Works, Bromyard Road
Worcester WR2 5DN
U.K.



IN-CHURN MILK COOLER

The in-churn immersion milk cooler illustrated above is supplied by:

ANIMATICS LTD.
Enterprise Road
Busia Road Corner
P.O. Box 72011, Nairobi
KENYA



HOME PASTEURIZERS

Small pressure-type pasteurizers with a capacity of 8-21 litres are supplied by:

ELECREM
49 bvd. de la Republique
92100 Boulogne Billancourt
FRANCE

CUMBERLAND GENERAL STORE
Rt. 3 Box 479, Crossville
T.N. 38555
U.S.A.

CHEESE VATS

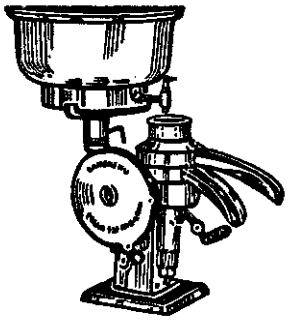
Small cheese vats from about 350 litres capacity and upwards and associated equipment are manufactured by:

DAIROW COMPANY
198 Western Avenue
Fond du Lac, Wisconsin 54935
U.S.A.

COMPLETE DAIRY INSTALLATIONS

THE ALFA LAVAL MINI DAIRY This is a complete dairy plant designed for sub-tropical and tropical regions which is capable of processing 100-600kg/h of raw milk into pasteurized milk, cheese or yoghurt. The plant may be powered by electricity or by a furnace. Other manufacturers can prepare similar systems to order, although most would prefer to quote for larger scale units.

ALFA-LAVAL AB
P.O. Box 1008, 221 03 Lund
SWEDEN



CREAM SEPARATORS

Manual and electric cream separators are available in a range of sizes. The separator illustrated is supplied by:

SINGHAL UDYOG (REGD.)
363 Azad Market, P.O. Box 1037
Delhi 110006
INDIA

The 24S and 50S are cream separators with capacities of 100 litres/h and 225 litres/h respectively available with manual or electrical drive from:

ALFA-LAVAL AB
P.O. Box 1008, 221 03 Lund
SWEDEN

These models are also supplied by:

GLIDDON & SQUIRE
Pottington Road, Barnstaple
Devon EX31 1JH
U.K.

Separators capable of processing 40, 80, and 95 litres/h, the largest of which can be electrically powered are supplied by:

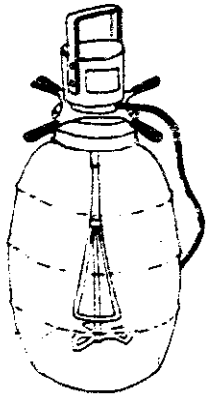
BUTTER BARREL COMPANY
Private Bag, Manurewa
Auckland
NEW ZEALAND

THE 9N-50 This is a small (50 litres/h) manual separator manufactured by the Qinghai Agriculture and Animal Husbandry Machine Factory and available through:

CHINA NATIONAL AGRICULTURAL MACHINERY
Import and Export Corporation
26 South Yeutan Street, Beijing
CHINA

THE ELECREM RANGE of cream separators. These manual and electrical models are available up to a capacity of 650 litres/h from:

ELECREM
49 bvd. de la Republique
92100 Boulogne Billancourt
FRANCE



SMALL BUTTER CHURNS

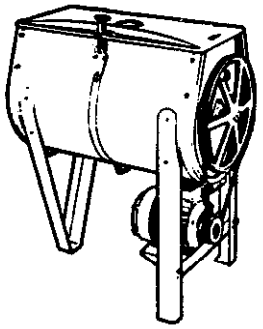
THE GEM DANDY This butter churn illustrated (left) is one of a range of small electrical butter churns of that name. It has a top-mounted electric motor and a churning capacity of 7 litres. Manufactured by the Alabama Manufacturing Co., U.S.A. and available through:

LEHMAN HARDWARE AND APPLIANCES INC.
Box 41, Kidron, Ohio
U.S.A.

A 4 litre capacity hand operated churn is available from:

CUMBERLAND GENERAL STORES
Rt. 3 Box 479, Crossville
T.N. 38555
U.S.A.

COBURN CO. INC.
834 E Milwaukee St. POB 147
Whitewater, WIS 53190
U.S.A.



LARGE WOODEN BUTTER CHURNS

THE ELBA This range of butter churns are made of iroko hardwood. Manual and electrical models in this range (the largest — 80 litres capacity — of which is pictured above) may be obtained from:

ELECREM
49 bvd. de la Republique
92100 Boulogne Billancourt
FRANCE

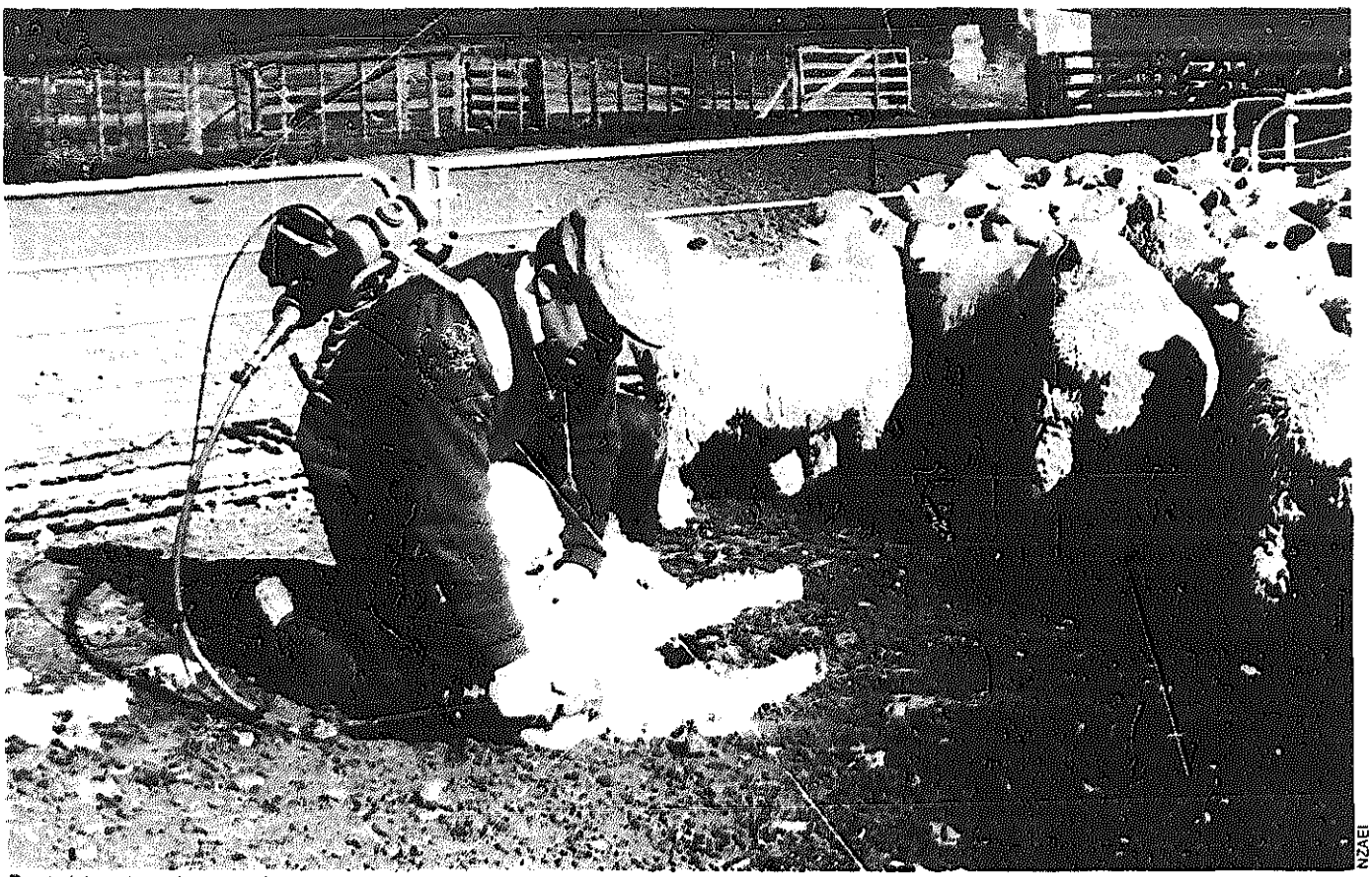
5 and 12 litre churns made of white pine are supplied by:

BUTTER BARREL COMPANY
Private Bag, Manurewa
Auckland
NEW ZEALAND

An 11-litre churn made from redwood is available from:

LEHMAN HARDWARE AND APPLIANCES INC.
Box 41, Kidron, Ohio
U.S.A.

11. WOOL HARVESTING



Portable shearing equipment.

The domestication of sheep and other animals such as goats and llamas, from which fibre is harvested, is as old as recorded history. Wool grows naturally on most sheep to protect them from the rigours of the climate; it keeps them warm and comfortable. People also like the warmth and comfort of wool, so each year most of the world's sheep are shorn for their fleece. The use to which wool is put depends largely upon the properties of the fibres which comprise the fleece, and this is determined by numerous environmental and genetic factors, of which breed is probably the most important.

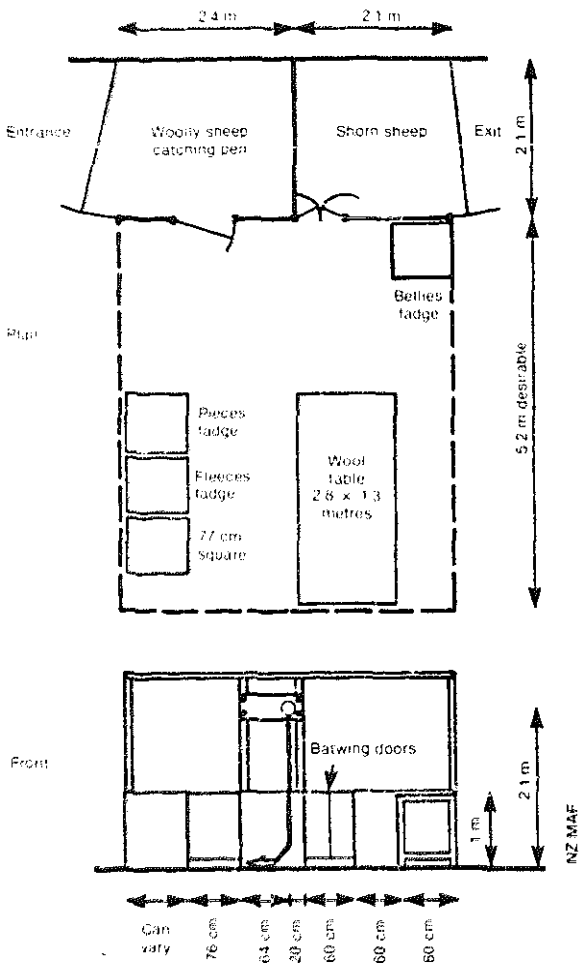
Sheep are farmed throughout the world, from the Arctic Circle to the extremes of the southern land areas. In particular, sheep have come to dominate extensive regions of the Southern Hemisphere, in Oceania, South America and Africa. This predominant rôle has led to a system of sheep farming — management, handling, meat and wool harvesting — based upon low labour requirements. Large flocks are kept, one man may, typically, control and care for more than 2000 head of sheep. This is in marked contrast to developing societies where full-time care may be given to flocks of 100 sheep or less; peasant children frequently spend all their formative years driving and tending the family flock.

The importance of large-scale sheep farming practices is, however, reflected in this section because of the innovation and development of wool-harvesting systems and equipment that have resulted. Much of this equipment is of Australian and New Zealand origin.

The key to proficient wool harvesting has always been adequate well-designed structures, whether temporary or permanent; fences, sheds, yards, pens, races, etc. are an intrinsic part of the system. Although these structures are generally beyond the scope of this guide they are important for the influence that they have had on the design and development of wool-harvesting equipment.

Plan the layout of yards and sheds so that stock and people can move with a minimum of effort. Provide the facilities that encourage handlers and shearers to perform at their best. Use methods and equipment which ease materials handling, particularly in the wool room where this is appropriate. Wool harvesting is normally a once a year activity, although sheep in some parts of the world are shorn two or three times a year.

In addition to complete fleece removal, wool is also regularly clipped from around the hind-legs and rump for hygiene purposes. In New Zealand this is called "crutching".



A small general-purpose building with a single stand can comfortably handle 400-600 sheep. Blade shearing, portable machines or fixed equipment can all be considered.

Wool harvesting equipment normally used in industrial countries comprises mechanical shearing plant and associated wool-handling aids such as tables, scales, presses and trollies. Peasant farmers typically have none of this equipment available; sheep are shorn with blades, and wool is collected and handled in traditional manner. In between the two extremes there are many variations, and there is usually scope and opportunity for improving sheep and wool handling on most farms — and improvements may enhance the standard of wool preparation and thereby enable it to attract more favourable market prices.

Blade shearing is an entirely practical proposition for harvesting wool, and was widely used by *all* wool-growers until the early part of this century. Blades have largely given way to mechanical shearing in the industrial countries since that time, although they are still favoured by some. In particular, blades remain popular for small flocks and for crutching, and where contamination of the fleece from dust, soil or vegetation is a major problem.

Mechanical shearing equipment.

Power for mechanical shearing can be obtained from mains electricity or from a small internal combustion engine. The latter can provide a direct mechanical link to shearing equipment through pulleys and drive shafts, or power a generator.

Mechanical shearing plant — and specialist wool-handling equipment such as presses — requires regular technical care and a spare parts back-up service. If these are not available locally, wool-growers should consider holding a selection of consumable spare parts. This will necessitate forward planning and purchasing, and if this is not practical wool-growers should remain with blade shearing.

Both mechanical shearing and blades have a rôle to play. The simplicity and low cost of blades should be compared with the faster work rate of mechanical shearing equipment. But speed and close shearing is not always desirable. Moreover, the cost of sophisticated equipment, and the problem of maintaining it and servicing it can present problems in some societies.

TECHNICAL CHARACTERISTICS

Technical development in recent years has enhanced sheep and wool-handling practices. There are opportunities for using this information and equipment, whatever the scale of wool harvesting planned.

Sheep-handling equipment

A regular delivery of sheep from pen to shearing stand is essential. After shearing the sheep must be promptly removed and the next one presented. The fleece is taken away simultaneously with the changeover of sheep. The design of the yards and shed available will vary according to local practice, but it is essential for the movement of stock to be as proficient as possible. A considerable selection of pens, races and gates are available to ease stock handling, of which a few are shown in the guide.

Sheep Handlers A mechanical frame for holding a single sheep. Used for a variety of purposes such as crutching, foot paring, ear tagging, etc. Several designs of sheep handler are available. Most could be made locally with simple metal-forming skills. Licenced manufacture should be considered.

Sheep-handler.

Shearing Tables A development of sheep handlers. The animal is securely held horizontally on a steel deck, thereby enabling the shearer to work comfortably in a normal standing position. As an aid to wool harvesting, shearing tables are particularly suitable for small flocks, learner shearers or those who suffer back problems.

Shearing equipment

Blades May vary in design and efficiency from simple pivot scissors to precision-made sprung blades of the finest steels. Long or short blades with single or double row bow spring designs are used. Available wherever sheep are farmed. Can be used for full shearing or crutching.

Shearing table.

Mechanical Shearing Equipment normally comprises a hand-piece, a drive-shaft and a source of power. Designs vary with technical progress; mechanical, electrical, electronic and air-powered equipment is available. The hand-piece has an oscillating cutter and rigid comb which cuts in both directions. It is slim, light-weight and well-balanced. Engineering tolerances are fine. The cutter crosses the comb at speeds of up to 6600 times each minute. The drive-shaft is flexible and made of gut, nylon core or steel shafting, and powered by a separate electric motor. Some earlier designs transmitted power through belt-driven steel shafts to a bank of shearing stands.

Power can be derived from any convenient source; internal combustion engine, generator or mains electricity. Even hand-cranked gearing has been used. Regular lubrication and maintenance is essential for prolonged trouble-free use. General-purpose and hand-piece maintenance tool-kits are required.

Portable Shearing Equipment Several designs are available which may be stand-alone, back-pack or fence-hung. Some units also incorporate a grinder wheel. Electric, petrol engine or tractor powered. Shearing onto

a clean surface with temporary structures and portable equipment (or blades) is a practical proposition for small flocks. Tractor-powered equipment may suit some wool growers.

Power Grinders: essential for regularly sharpening mechanical shearing equipment. Double and single disc grinders are available. Electric or line-shaft power. A clamping plate, glue and a supply of grinding papers are required. (Blades do not require a power grinder; a general purpose foot- or hand-cranked grinding wheel is preferred. When ground, hone the blades with an oilstone.)

Wool-handling equipment

After shearing, the fleece may be skirted, classed, stored in bins, pressed into bales and stored in readiness for transport. Specialist equipment has been developed to aid each step. Much of it can be fabricated locally, using foreign designs if necessary.

Wool Table: of either circular or rotating or fixed rectangular design for one-man or two-man use, respectively. Each fleece is spread on the table for inspection. Soiled or faulty pieces are removed, and each fleece is rolled separately in readiness for classing and pressing. Two tables are advantageous when four or more shearing stands are used.

Wool Bins: these help separate and store individual fleeces and the various sweepings, damaged and soiled pieces of wool. Bins can be permanent or temporary fixtures, and made of a variety of materials such as galvanized steel, timber, wire mesh or steel frames with jute or plastic inserts.

Wool Press: consolidates complete fleeces or pieces into a transportable package that is easily handled by simple hand-tools and mechanical aids. If wool is entering international trade, baling is essential. Bales are usually packed in jute sacks and weigh from 45-150kg according to accepted local practice. The bales are sewn closed and marked with a standard code to indentify the kind of wool, its origin, bale number, etc. Stencils and stencil brushes are required. Wool presses vary from the simple manual winch to automated electro-hydraulic designs. Some have weighing scales. They are normally of timber or steel and timber construction.

Bale handling aids

A simple steel hook and a bale trolley (with steel wheels or hard rubber tyres) are indispensible when manoeuvring wool bales. Bale lifters and hoists are also required for stacking and loading bales into store and onto road trucks.

Scales: it may be important for the wool-growers to have a record of wool weights, either from individual animals or from the whole flock. Such records aid decisions for breeding or decisions for marketing, for example. Fleece or bale scales of various types are available; they require regular calibration and careful use.

The importance of choosing carefully

Well-designed sheep handling facilities will enable sheep to be presented to the shearers quickly and with minimum effort. Suitable and well-maintained equipment will enable the shearer to remove the fleece with a minimum of cuts and damage to stock, and with a minimum of physical effort. The training and self-discipline required of the shearer is an important factor that will help avoid stress or injury both to himself and to stock. (In the wool shed adequate sorting and storage space and equipment will enhance the quality of work. Improved wool-handling techniques and shed designs can be adapted from experienced wool-growers. These can be obtained from national or international agencies if they are not available locally.)

Apart from the small numbers of sheep that naturally shed their wool annually, or those from which wool is plucked, some kind of specialist shearing equipment is always essential for removing wool. Alternative cutting equipment, such as general-purpose types of scissors, secateurs or knives which may be available to the wool-grower are not satisfactory. They are a hazard to both stock and handlers, and the value of the fleece will be lowered if it is not removed cleanly.

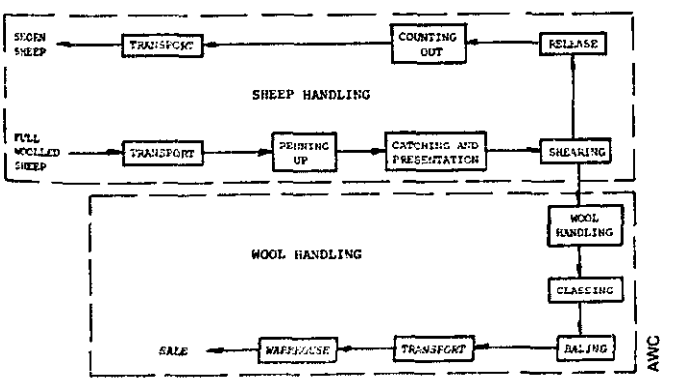
The choice of suitable shearing equipment available is therefore relatively narrow. A pair of blades and sharpening stones is one low-cost approach; blades require no auxiliary power source. Mechanical or electrical shearing equipment generally reduces the laborious effort required of blade shearing, although the techniques differ. Shearing is more even and loss of wool is minimized. Most of the wool that enters international trade is harvested mechanically, and the care and use of mechanical equipment is within the ability of most wool-growers, although the financial implications require careful consideration. Purchase and operational costs are high when compared to blade shearing.

Costs and benefits

The infrastructure required for harvesting wool from large flocks — yards, sheds, fixtures and equipment — is considerable. Cost will depend upon stock throughput and local manufacturing and building rates. Mechanical equipment may have to be imported, which will add further costs.

In New Zealand, for example, in mid-1984 a modern two-stand building of 72m^2 with yards attached may cost of the order US$10,000-12,000, complete and ready for shearing. It could comfortably handle a flock of 1000 sheep.

For small flocks, of say 100 sheep or less, it is entirely practical to construct a temporary enclosure, for example by using portable gates or fences, and to blade shear onto a tarpaulin alongside. An experienced blade shearer can handle more than 60 sheep a day, with support. In between a permanent single-purpose facility and a temporary structure a variety of arrangements can be devised.



Wool harvesting comprises all the activities associated with shearing, including stock handling, fleece removal and wool handling. Consider these activities in sequence as a system.

Indicative costs

Some indication of the costs of the sheep- and wool-handling equipment required for these facilities is shown below.

	Capital costs (US$)	Running costs (Repairs and maintenance) (US$)	Infrastructure
Sheep-handling equipment			
Shearing plant	450	25	Electric power
Power grinder	450	30	Electric power. Spare grinding papers & glue
Portable plant	300	25	Gasoline supply
Tractor-mounted plant	225	20	Tractor required
Hand piece	175	15	
Comb and cutter	12	2	Two or more sets required
Blades	10	2	
Grinding & sharpening stones	50	5	Hand cranked
Handler & race	700	30	Semi-permanent fixture
Shearing table	400	30	
Wool-handling equipment			
Fleece weigher	100	8	Wall mounted
Wool table	150	12	Circular
Wool bin	175	15	Free standing
Wool pack, jute	3		
Pack holder	75	5	
Wool press, hydraulic	2250	300	Power required
Wool press, manual	700	50	Hand-winch
Stencils	20		
Barrow & hook	100	10	Rubber tyred

Economics

Costs begin to be incurred from the moment the stock is assembled for shearing, and continue until the sheep are moved back to pasture, and the wool is transported away. For a small domestic flock these additional handling costs will be low; for a large flock gathered over a wide area, stock and wool-handling costs will be high.

Costs can always be considered as fixed and variable. Fixed costs will cover depreciation, interest, insurance, and maintenance of sheds and yards. Variable costs are all the others, and include transport, shearing, labour, materials, repairs and maintenance to equipment, wool baling and bale handling. (For temporary shearing arrangements all costs are variable.)

The performance of a particular wool-harvesting system will be governed by a number of factors, including design and layout, the experience of shearers and handlers, and the nature of the sheep themselves. Even the prevailing weather is important. Stock throughput is a popular yardstick, measured per day or per hour. The cost per bale, or cost per sheep shorn, are alternative measures. A wool-grower must take into full account any personal labour or family labour when assessing true costs.

Costs for *your* particular wool harvesting requirements will clearly vary, but the following examples may be a useful guide.

Example 1

Annual wool-harvesting costs for a single stand facility housed in a general-purpose building, and with adjoining yards; proprietary equipment used.

Fixed Costs	*US$*
Cost of buildings and yards at US$4500 financed by a 10-year term loan at 15% pa. Half cost attributable to wool harvesting; remainder to other farm uses.	335
Cost of equipment at US$2400. Financed by a 10-year term loan at 15% pa.	360
Depreciation of structures and equipment over 10 years. Zero resale value.	690
Insurance.	30
Repairs and maintenance of structures at 10% of purchase cost.	450
Total fixed costs	1865

Variable Costs	*US$*
Movement of stock to and from yards.	40
Labour; 2 men for 6 days at US$42.50/day.	510
Materials.	125
Repairs and maintenance of equipment at 12% pa of purchase cost.	285
Wool baling, storage and transport from yard.	180
Power.	60
Miscellaneous costs at 10% of total variable costs.	120
Total variable costs	1320
Total costs	3185

For a throughput of 600 head of stock annually, the wool-harvesting cost is of the order US$5 per animal is clearly a significant cost, and is only practical with high-yielding wool sheep such as Merinos or Crossbreds (4kg per fleece). For low-yielding wool sheep (1-2kg per) fleece) a cheaper wool-harvesting cost is essential.

Example 2

Annual wool-harvesting costs for a temporary yard of local materials, and blade shearing on to a tarpaulin. Local wool storage for home use.

	US$
Fixed Costs	nil
Variable costs	
Movement of stock.	40
Labour, 2 men for 10 days at US$42.50/day each.	850
Materials, fencing, tarpaulins, timber, sacking, etc.	325
Equipment, blades and stones	80
Wool packaging, storage and transport	50
Miscellaneous at 10% of total costs	130
Total costs	1475

For the same size flock (600 head) wool-harvesting costs will be US$2.50 per animal.

In New Zealand, contract shearing teams are available for hire for wool harvesting. The farmer is expected to

provide all the required shearing facilities and equipment, including accommodation and cooking facilities for staff. Sheep must be delivered to the team as required. Complete shearing, including all woolshed labour for stock and wool handling will cost of the order US$62.50 for 100 sheep. A team may contain two or more shearers, and throughput will be high.

Scale of equipment

Wool harvesting requires specialist equipment that may be expensive to purchase. But this equipment is essential for harvesting quality fleeces. The cost of the equipment can be minimized by sharing it with others. Use the equipment and facilities as much as possible; handle as many stock as time will allow. Consider harvesting fibres from other animals in addition to sheep, such as goats.

The preferred choice of equipment and system of use will clearly depend upon the scale of wool harvesting required, and the finances available to the wool-grower. A number of options will present themselves; consider:

- *Cost* Is there sufficient justification for the level of expenditure planned? Is there sufficient cash available to meet purchase costs? If money is loaned for purchases, can it be repaid satisfactorily?
- *Capacity* Does the choice of sheep and wool-handling facilities match the size of the flock? Is there room for expansion?
- *Location* If the equipment and facilities are located permanently in one place will it suit all those who expect to use it? Would temporary locations and portable equipment be more suitable?
- *Availability* Is the equipment already available locally from a reputable supplier. If not, is anyone willing to manufacture or sell this equipment in the district? What kind of spare parts, power and advisory service is on hand?
- *Experience* Is the equipment easy to use? Can tuition be obtained either locally or at a national training centre? What local skills exist for maintaining and servicing the equipment?
- *Socially acceptable* Will the choice of system and equipment be readily acceptable to local people? What changes to existing social practice will be required? Will the new ways be easy to understand and use? Has the demand for change come from the community or from outside?

Having short-listed the most suitable equipment, an economic evaluation of all inputs and outgoings associated with them will help identify the best choice. Compare the new methods of wool harvesting with current practices. Some aspects of the new methods may be difficult to quantify economically. An improvement in health or leisure time, for example, clearly has great value socially. Selecting equipment on price alone also presents problems. Quality is important. When making a choice always buy the best that funds will allow. Seek advice from those with experience of the equipment selected *before* buying.

The seasonal nature of shearing will mean that facilities and equipment are used for only a few days in the year; this exacerbates their cost to the wool-grower. Many wool-growers use their sheds for general storage purposes during the remainder of the year. Races and yards can also be used for other annual stock-handling activities such as drenching, weighing, selecting and selling.

Health and safety

Shearing is hard work and requires a strong wrist and a flexible back. Blade shearing is more demanding than machine shearing. The key to minimizing physical effort is style. A quiet methodical approach to shearing, without excessive movement or flourish, is essential. The animal is balanced against the shearer and their combined weight, of 140kg or thereabouts, is co-ordinated with the requirements of the hand-piece or blades. The sheep is continually being moved into position for the next blow. This is a highly skilled sequence of movements that may take several years to master.

Speed must never be a substitute for quality. Damaged stock or damaged wool will reduce the value of the harvest. Care must be taken not to injure stock where they are most vulnerable; place the fingers of the free hand over the teats of the ewe when cutting near them and take care with the pizzle of the male.

Sheep are remarkably hardy animals, but even the most hardy constitution will be susceptible to infection from open wounds. Mark any wounded stock and treat them accordingly. Simple first-aid equipment and supplies should be available whenever shearing or crutching is in progress. Surgical needles and thread should also be available for stitching badly cut sheep.

Wool-growers are fully responsible for their own safety, that of their workers and their stock. Maximize safety by providing suitable shearing equipment in good order, healthy and clean stock, and a working environment that is light and well ventilated. Provide shade if necessary.

Social impact

Wool harvesting is normally a time of great social activity. It may be the focal point of the farming year, when neighbouring farms or villages muster stock for the shared responsibility of shearing. Sharing work and facilities helps to reduce effort and cost. The greater the throughput of stock the lower the incremental cost of harvesting.

Improvement stock and wool-handling facilities help to reduce the level of drudgery involved: they also ease the physical burden of those who handle both sheep and wool. A knowledge of stock behaviour will impart less stress on both animals and people.

Sophisticated equipment such as shearing machines and mechanical or hydraulic wool presses will bring a degree of dependency upon external suppliers. This is probably unavoidable if high output, and enhanced-standards systems of harvesting, are required. Carefully evaluate the manufacturers concerned with the sources of supply for important spare parts before purchasing. With both a measure of forward planning, and some initial technical skills, these systems can work satisfactorily in the most isolated community. A supply of power is, however, normally required.

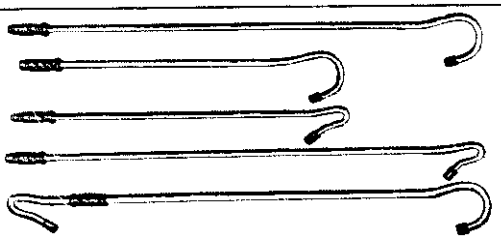
Blade shearing requires similar skills, but without the dependency inherent in many mechanical systems. Yard and shed facilities should be of the most convenient design for maximum efficiency of stock and wool handling. Many wool-growers prefer the quiet nature of blade shearing. The system can be operated with little or no demand for external assistance.

Special considerations

Training is an essential part of all farm activities, and wool harvesting is no exception. Although basic training can be taught from formal instruction, practical experience is essential. Training should complement the experience gained from local experts. Traditional requirements vary widely however, and particularly between breeds. Merino and Crossbred sheep together produce most of the world's wool, but the style of shearing required by each differs considerably.

The different skills, knowledge and managerial expertise required of blade and mechanical shearing practices should be recognized. Seek advice from suppliers of equipment if this is available. Is training available for one or two local people before changing practices? Try to acquire these skills during the season before the change is made. The social problems that may arise from a failure to introduce new ideas successfully can be a major barrier to progress. Seek consensus and discussion with those involved before making changes; do this before making any major purchases. The differences in wool harvesting practices between the industrialized farming regions of the world and many peasant communities is considerable. Seek advice from agencies in countries from where you expect to adopt new ideas or buy equipment.

Peter Steele
NZ Agricultural Engineering Institute



LIGHT-WEIGHT ALLOY SHEPHERDS' CROOKS

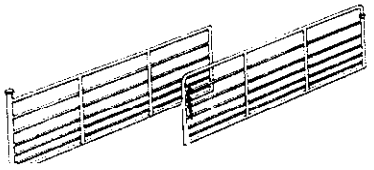
These crooks are non-rusting and non-warping. Made from light-weight alloy, the three neck models with semi-circular ends are tubular, whilst the two sharply bent-leg model crooks are solid.

Also illustrated is the dual purpose leg-and-neck model which has a sliding handle.

Crooks are valuable shepherding aids which traditionally, in some countries, are made from rustic materials. These can prove heavy and cumbersome and the light-weight aluminium crooks illustrated above can be a great improvement.

Among many suppliers of shepherds' crooks is:

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.



SHEEP YARDS AND HANDLING SYSTEMS

SHEEP HURDLES These form the basis of a multitude of designs of yard for handling sheep. Those illustrated above are of tubular steel and are supplied by:

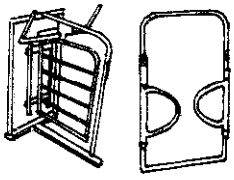
BORAL CYCLONE LTD.
P.O. Box 77, East Bentleigh
Victoria 3165
AUSTRALIA

MOBILE SHEEP YARDS These may be transported by trailer, and are available from:

PRATTLEY ENGINEERING LTD.
P.O. Box 109, Vine Street
Temuka, South Canterbury
NEW ZEALAND

THE HAMILTON BUGLE is a converging curved forcing race which brings sheep into single file to enter the loading race of a sheep handler. Manufactured to order by:

A.J. WALSTER & SON
Jaffre Street
Junee N.S.W. 2593
AUSTRALIA

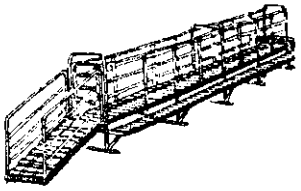


DRAFTING AND NON-RETURN GATES

Drafting gates (above left) are invaluable for separating groups of sheep smoothly and quickly without stress to the animal.

Non-return gates (above right) prevent sheep backing down the race to avoid treatment. Both these gates are available from:

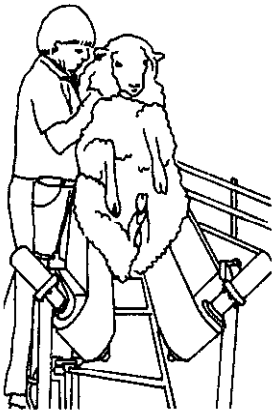
ERNEST HAYES (NZ) LTD
789 Main South Road
P.O. Box 23042, Christchurch 4
NEW ZEALAND



SHEEP RACES

A race is an essential part of any efficient sheep-handling system. It enables sheep to be singled out for individual attention. The race illustrated above is available from:

BORAL CYCLONE LTD.
P.O. Box 77, East Bentleigh
Victoria 3165
AUSTRALIA



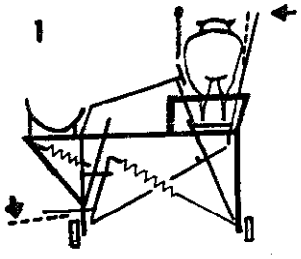
CONVEYOR SHEEP HANDLING

This handling system is designed to cut the back-breaking chores out of sheep handling.

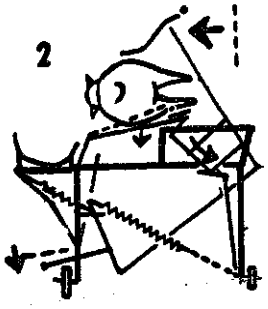
Once the animal enters the race it is caught and held by the conveyor for easy treatment. For dagging and foot treatment the animal may easily be flipped onto its back by the operator. This machine is available from:

HYDES MANUFACTURING LTD.
12-20 William Street
Ashburton, P.O. Box 344
NEW ZEALAND

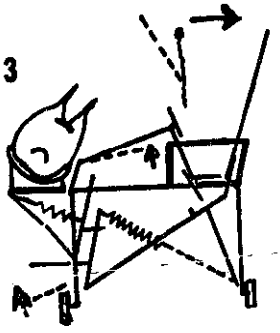
WILLETTON ENGINEERS
13A Davison Road
Maddington W.A. 6109
AUSTRALIA



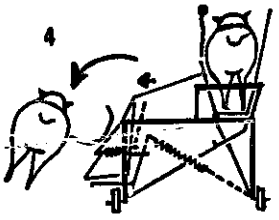
Sheep enters race and is secured in a cage. All movements of the machine initiated by foot levers.



Cage tips towards the operator throwing the sheep off balance.



The sheep then slides into a shaped cradle for crutching.



Sheep rolls out of cradle to land on its feet.

MECHANICAL SHEEP-HANDLING SYSTEMS

A number of mechanical sheep-handling systems are available which are designed to increase work rate and decrease the heavy work involved in treating sheep. Sheep cannot be shorn in these machines, but crutching, wigging and dagging may be carried out along with inoculating, drenching and foot paring.

THE GUN CRUTCHA shown in operation above is an example of the most complicated type of mechanical handler. In these types sheep are handled entirely by the machine, which is operated by foot levers. This is manufactured by:

DONALD PRESSES LTD.
P.O. Box 138, Masterton
NEW ZEALAND

VERMEEREN BROS. (ENGINEERING)
26 Wynarliug Road
Keith S.A. 5267
AUSTRALIA

THE JETSTREAM OR ALLBULK SHEEP MASTER is similar in principle to the illustration. This is available from:

AUSTRALIAN AGRICULTURAL MACHINERY GROUP PTY. LTD.
73 Abernethy Road, P.O. Box 157
Belmont, W.A. 6104
AUSTRALIA

ALLBULK AGRICULTURAL EQUIPMENT
Boothenba Road, Dubbo
N.S.W. 2830
AUSTRALIA

A second type of machine is manufactured, which differs from that illustrated in that the sheep once caught in the race must be pulled manually onto the working table or cradle.

THE LUBCKE HANDLING CRADLE is of this type and is available from:

STRUCTURES PTY. LTD.
Bennet Avenue, Edwardstown
S.A. 6039
AUSTRALIA

PEDERICK ENGINEERING
90 Tudhoe Road
Wagin, W.A. 6315
AUSTRALIA

THE DAVID PAYNE SHEEP HANDLER is also of this type. Supplied by:

DAVID PAYNE & CO.
255 Star Street, Welshpool
W.A. 6106
AUSTRALIA

WRIGHTSONS NMA LTD.
P.O. Box 1895, Wellington
NEW ZEALAND

THE HENRY SHEEP HANDLER is another type of mechanical handling aid and is a simpler system. The sheep is clamped firmly between two sides of a catching pen which may then be rotated to a horizontal position for ease of work. In this type of machine the sheep is not placed on a working table or cradle. This handler is manufactured by:

HENRY ENGINEERING LTD.
Lobum, Rangiora Rd. 2
NEW ZEALAND

CRUSH-TYPE SHEEP HANDLING PENS

These pens, which are normally inserted in a race, permit each sheep to be caught and held firmly in a standing position for crutching or other treatment.

MAC'S IDEAL DAGGING PEN This is illustrated and is distributed by:

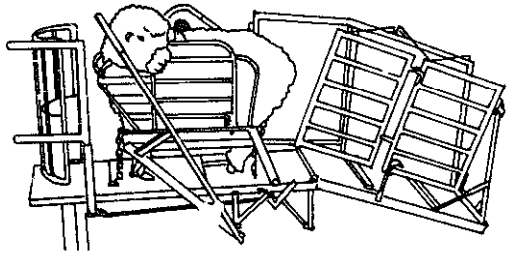
R.E. MONTEATH, George Road
PO Southland, AUSTRALIA

THE WOOLCOCK 'PORTA CRUTCH' This is a similar model available from the manufacturer.

WOOLCOCK ENGINEERING
P.O. Box 79, Yankalilla
S.A. 5203, AUSTRALIA

THE CRUTCH-EASY This is operated by compressed air.

HEENAN ENGINEERING CO. LTD.
P.O. Box 890, Winton
NEW ZEALAND

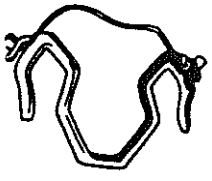


ALL-PURPOSE SHEEP HANDLER

THE HECTON TIP-EZI is another mechanically operated sheep handler designed to take the hard work out of sheep handling.

The sheep may be held in a standing position for crutching, injecting or drenching or tipped backwards using a hand-lever system. In this second position the sheep's feet may be attended to. This attractive design is available from:

JOHN A. HECTOR
Otahuti R.D.4, Invercargill
NEW ZEALAND



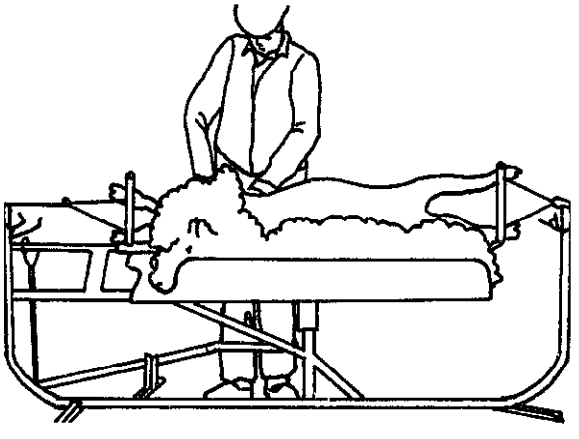
THE GAMBREL RESTRAINER

This is probably the simplest method of holding and pacifying a sheep. When fitted, it immobilizes the sheep allowing numerous operations including dagging, foot trimming and lambing to be carried out. Sheep may also be transported without a crate when held in this fashion.

The restrainer (above right) is fitted over the back of the neck. The feet are placed in the hooks provided and the elastic fastened under the neck (above left).

This simple tool is supplied by:

AG-LINE PRODUCTS
Box 1030, Napier
NEW ZEALAND



SHEARING TABLES

THE MOFFATT SHEARING TABLE This table, illustrated above, is designed to remove bending and doubling from the shearing operation. Complete novices can learn to shear efficiently within a few days using this equipment. Other husbandry tasks can be carried out while the animal is held on the table.

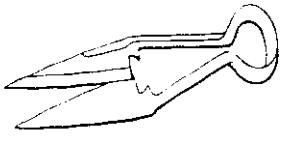
The operation of the table is simple. First the animal is placed on its back on the roller bed which has one end tilted to the floor. The bed then tips to a horizontal position under the animal's own weight and its feet are secured in an extended position in self-adjusting holders. Shearing is facilitated by a foot pedal connected to rollers in the bed. These rollers will rotate the animal through 360 degrees. The intact fleece which has been removed collects in a tray alongside the rollers. The shorn animal is then released and slides gently to the floor.

This durable shearing table is manufactured by:

MOFCO INDUSTRIES LTD.
P.O. Box 48, Otaki Railway
North Island
NEW ZEALAND

THE NEWMAN PNEUMATIC SHEARING TABLE This is a slightly different design. In this system the sheep is secured on the table whilst at ground level. The table is then lifted pneumatically to a comfortable height for shearing. This equipment, which is part of a shearing system designed to help the non-professional shearer make a professional job, is produced by:

NEWMAN SHEARING EQUIPMENT
65 Gertrude Street
Fitzroy, Victoria 3065
AUSTRALIA



SINGLE-BOW SHEEP SHEARS

Hand shears were the only means of shearing sheep until mechanical shearing was developed in this century. In skilled hands they are an entirely practical way of harvesting wool, and in some instances even preferable to mechanical shears. For dagging and crutching, in small flocks, and when it is desirable not to clip too closely, hand shears are favoured.

They can be supplied by:

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.

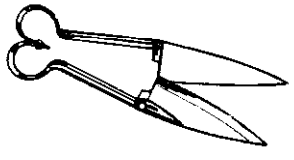
CEKA WORKS LTD.
Caernarvon Road, Pwllheli
Gwynedd LL53 5LH
U.K.

DALTON SUPPLIES LTD.
Nettlebed
Henley-on-Thames RG9 5AB, Oxon
U.K.

JENKS & CATTELL LTD.
Phoenix Works, Neachells Lane
Wednesfield
Wolverhampton W11 3PU
U.K.

KUMAON NURSERY
Ramnagar - 244715
Nainital, U.P.
INDIA

COLUMBIAN CUTLERY CO. INC.
P.O. Box 123, 440 Laurel St
Reading, Pennsylvania 19603-0123
U.S.A.



DOUBLE-BOW SHEEP SHEARS

Hand shears of the double bow design can be supplied by:

COLUMBIAN CUTLERY CO. INC.
P.O. Box 123, 440 Laurel St.
Reading, Pennsylvania 19603-0123
U.S.A.

ERVEN G. DE BOER BV
Westerplantage 1-7
8911 DC Leeuwarden
NETHERLANDS

CEKA WORKS LTD.
Caernarvon Road, Pwllheli
Gwynedd LL53 5LH
U.K.

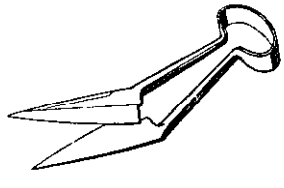
COSMO INCORPORATED
Towa Bldg 4th Floor
10,4 -Chome, Awaji-machi
Higashi-Ku, Osaka
JAPAN

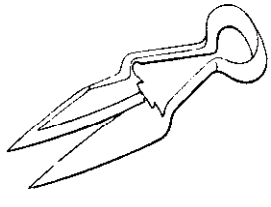
DALTON SUPPLIES LTD.
Nettlebed
Henley-on-Thames RG9 5AB, Oxon
U.K.

H. HAUPTNER
Postfach 2201-34
D 5650 Solingen 1
W. GERMANY

JENKS & CATTELL LTD.
Phoenix Works, Neachells Lane
Wednesfield
Wolverhampton WV11 3PU
U.K.

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.

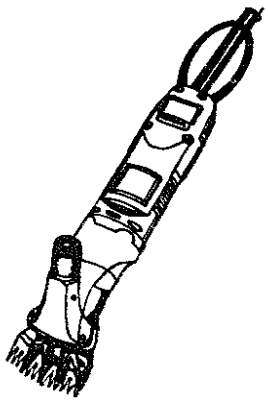




OTHER DESIGNS OF HAND SHEARS

Personal preference and particular tasks have led to the development of other designs. Dagging shears with bent handles (above left), and shears with bent handles (above right) are supplied by:

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.



ELECTRIC SHEEP SHEARS

Shearing machines such as the Wolseley electric shearing machine (illustrated left) have the motor contained within the hand-piece. Further machines of this type are available from other suppliers.

WOLSELEY ENGINEERING PRODUCTS
Bath Road, Woodchester, Stroud
Glos. GL5 5EX
U.K.

EIDER-LANDGERÄTE KG
Postfach 1349
2240 Heide/Holstein
W. GERMANY

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.

HEINIGER & CO.
CH-3360, Hertzogenbuchsee
SWITZERLAND

THE GALLAGHER P.T.O.-DRIVEN SHEARING DRIVE

In small remote areas a tractor power take off shearing drive may be most suitable. This may be fitted to any 540rpm to 1000rpm tractor power take-off. It powers two flexible drive shafts. The tractor engine speed is adjusted to achieve the desired cutter speed at the hand-piece.

GALLAGHER ENGINEERING LTD.
Private Bag, Frankton
Hamilton
NEW ZEALAND

ELECTRIC SHEARING MACHINES WITH SHAFT DRIVE

When large numbers of sheep are to be shorn the most common type of machine is that in which drive from an overhead motor is transmitted to the hand-piece via a shaft.

THE HAUPTNER-MERINO ELEKTRO SHEEP-SHEARING MACHINE (illustrated right) is of this type. It may be fitted with either the more conventional rigid shaft (on the left) or a flexible drive shaft (on the right).

H. HAUPTNER
Postfach 2201-34
D 5650 Solingen 1
W. GERMANY

Other machines of this type which are fitted with conventional rigid drive shafts are supplied by:

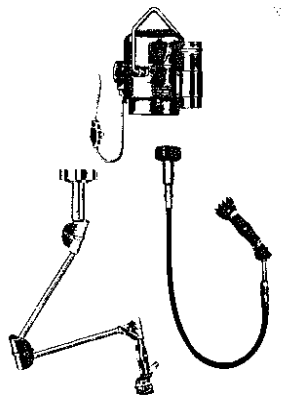
M.J. HOOPER & COMPANY LIMITED
P.O. Box 21083, Henderson
NEW ZEALAND

DALGETY CROWN LTD.
P.O. Box 1397
Wellington
NEW ZEALAND

Flexible drive allows greater mobility and facilitates shearing in a wider range of sheep-handling equipment. Other machines capable of powering a flexible drive shaft are supplied by:

DALGETY CROWN LTD.
P.O. Box 1397
Wellington
NEW ZEALAND

WRIGHTSONS NMA LTD.
P.O. Box 1895, Wellington
NEW ZEALAND



MOTORIZED SHEARING

In some situations in which it is desirable to use a mechanical shearing machine a supply of electricity may not be available. Petrol driven models are used in these situations.

LISTER MOTORIZED DAGGING PLANT This is powered by a 2-stroke motor. It is light-weight and portable, and comes with a flexible tube.

DALGETY CROWN LTD.
P.O. Box 1397
Wellington
NEW ZEALAND

SUNBEAM FARM MODEL This electric powered model can be converted to a petrol-driven version.

WRIGHTSONS NMA LTD.
P.O. Box 1895, Wellington
NEW ZEALAND

ELECTRICAL DISC GRINDERS

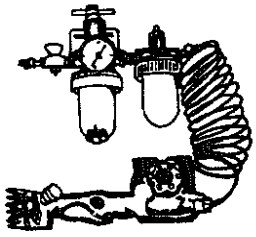
A power grinder such as the Kiwi double-ended electric grinder (illustrated above) is essential for the regular sharpening of mechanical shearing equipment. This grinder can be supplied by:

M.J. HOOPER & COMPANY LTD.
P.O. Box 21083, Henderson
NEW ZEALAND

Precision-machined grinders of this type can also be supplied by:

DALGETY CROWN LTD.
P.O. Box 1397
Wellington
NEW ZEALAND

WRIGHTSONS NMA LTD.
P.O. Box 1895, Wellington
NEW ZEALAND



THE 'ABLE STAR' PNEUMATIC SHEARER

This has a compressed air motor in the hand-piece itself. It is manufactured by:

AIR SHEARING PTY. LTD.
11 River Road
Bayswater W.A. 6053
AUSTRALIA

SHEARING HAND-PIECES

The hand-piece is attached to the drive-shaft of a conventional mechanical shearing machine. It should be slim, light-weight and well balanced. It contains an oscillating cutter and a rigid comb which cuts in both directions.

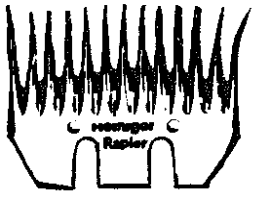
The Hauptner Merino sheep-shearing hand-piece (illustrated left) is available from:

H. HAUPTNER
Postfach 2201-34
D 5650 Solingen 1
W. GERMANY

Other manufacturers of shearing handpieces are:

DALGETY CROWN LTD.
P.O. Box 1397
Wellington
NEW ZEALAND

WRIGHTSONS NMA LTD.
P.O. Box 1895, Wellington
NEW ZEALAND



COMBS AND CUTTERS

A wide range of combs and cutters are available to suit all types of wool and shearing conditions.

THE HEINIGER RAPIER This comb (illustrated above left) is especially designed for shearing dense or sticky wool.

HEINIGER XP4 FOUR-TOOTH CUTTER This oscillating cutter (illustrated below left) and the comb are manufactured by:

HEINIGER & CO.
CH-3360, Hertzogenbuchsee
SWITZERLAND

Other manufacturers and suppliers of combs and cutters include:

EIDER-LANDGERÄTE KG
Postfach 1349
2240 Heide/Holstein
W. GERMANY

ALFRED COX (SURGICAL) LTD.
Edward Road, Coulsdon
Surrey CR3 2XA
U.K.

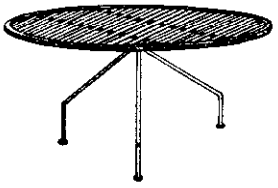
WRIGHTSONS NMA LTD.
P.O. Box 1895, Wellington
NEW ZEALAND

DALGETY CROWN LTD.
P.O. Box 1397
Wellington
NEW ZEALAND

LAMB BATS

Wool sweeps and lamb bats may be useful to help move wool from the shearing platform. The lamb bats illustrated are available from:

FARM-ACY (NZ) LTD.
399 Ferguson Street
P.O. Box 30, Palmerston North
NEW ZEALAND



WOOL TABLES

Wool tables are used for sorting and rolling wool. They provide a clean surface at a comfortable height for working. All wool tables mentioned below may be obtained as models capable of weighing the fleece.

CIRCULAR WOOL TABLE The circular wool table illustrated is available from:

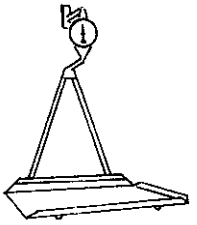
DONALD PRESSES LTD.
P.O. Box 138, Masterton
NEW ZEALAND

CIRCULAR WOOL TABLE Another circular table is supplied by:

ERNEST HAYES (NZ) LTD.
789 Main South Road
P.O. Box 23042, Christchurch 4
NEW ZEALAND

WOOL-ROLLING TABLE A rectangular wool table is manufactured by:

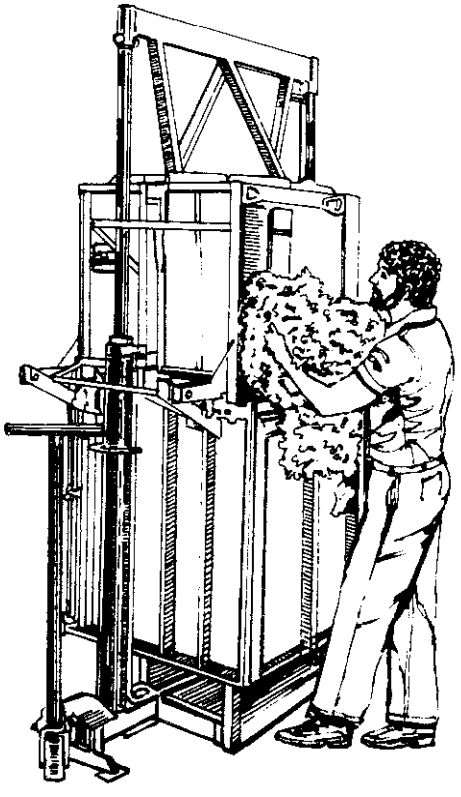
BORAL CYCLONE LTD.
P.O. Box 77, East Bentleigh
Victoria 3165
AUSTRALIA



DONALD FLEECE WEIGHER

This is designed to simplify and speed up the process of weighing fleeces. Fleece weight may be used as a basis for culling breeding ewes. This weigher is manufactured by:

DONALD PRESSES LTD.
P.O. Box 138, Masterton
NEW ZEALAND



HYDRAULIC WOOL PRESSES

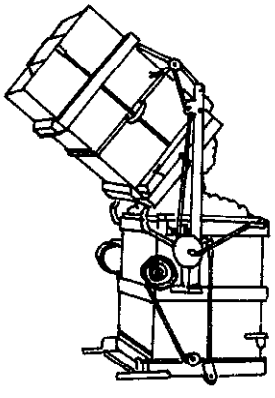
For international trade it is essential that wool should be pressed into bales. In wool presses of this type the wool is loaded by hand — first into the wool pack in the lower box, and then into a top box. The wool is then compressed into the lower box by hydraulic rams. The top box may be refilled several times before the bale is full and ready to be sewn shut.

THE STEVLYON AUTOMATIC SELF PINNING WOOL PRESS This is manufactured by:

ERNEST HAYES (NZ) LTD.
789 Main South Road
P.O. Box 23042, Christchurch 4
NEW ZEALAND

DONALDS HYDRAULIC WOOL PRESS is available from:

DONALD PRESSES LTD.
P.O. Box 138, Masterton
NEW ZEALAND

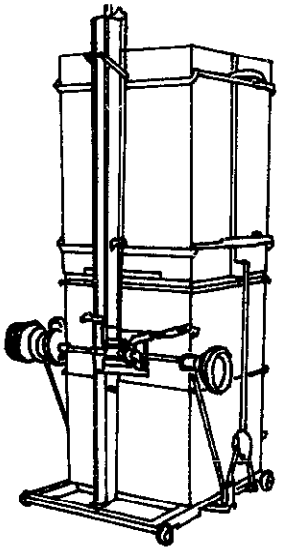


THE SANDOW TIP-OVER WOOL PRESS

This simpler type of wool press consists of two boxes hinged at one edge. Both boxes are filled with wool before the left-hand box is hoisted over the bottom box which contains the wool pack.

The wool from the top box may then be compressed into the wool pack by a second winch mechanism.

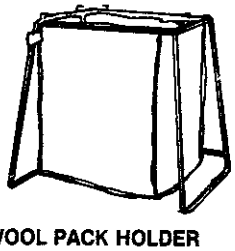
DONALD PRESSES LTD.
P.O. Box 138, Masterton
NEW ZEALAND



THE SANDOW VERTICAL-HOIST WOOL PRESS

In this type of wool press both boxes are filled on the floor. Wool pins keep the wool in place while the top box with cap on top is raised up the pole and swung round onto the bottom box ready for pressing. Pressing may be done manually using a single lever. Alternatively, the press may be fitted with an electrical pressing unit. The whole machine may easily be operated by one person.

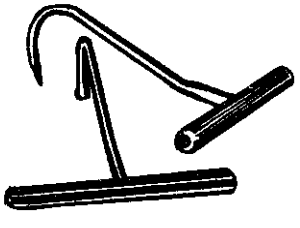
DONALD PRESSES LTD.
P.O. Box 138, Masterton
NEW ZEALAND



WOOL PACK HOLDER

If wool is to be packed by hand rather than pressed by machine, a pack holder such as this one illustrated might be useful. The wool pack may be quickly attached to spikes around the top. These spikes are guarded for safety.

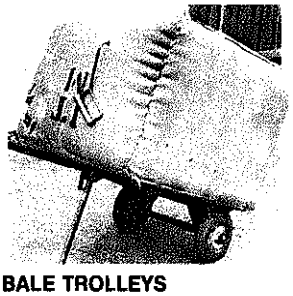
DONALD PRESSES LTD.
P.O. Box 138, Masterton
NEW ZEALAND



BALE HOOKS

Bale hooks are simple traditional tools which are used to make large unwieldy wool bales easier to handle. Those illustrated are supplied by:

DONALD PRESSES LTD.
P.O. Box 138, Masterton
NEW ZEALAND

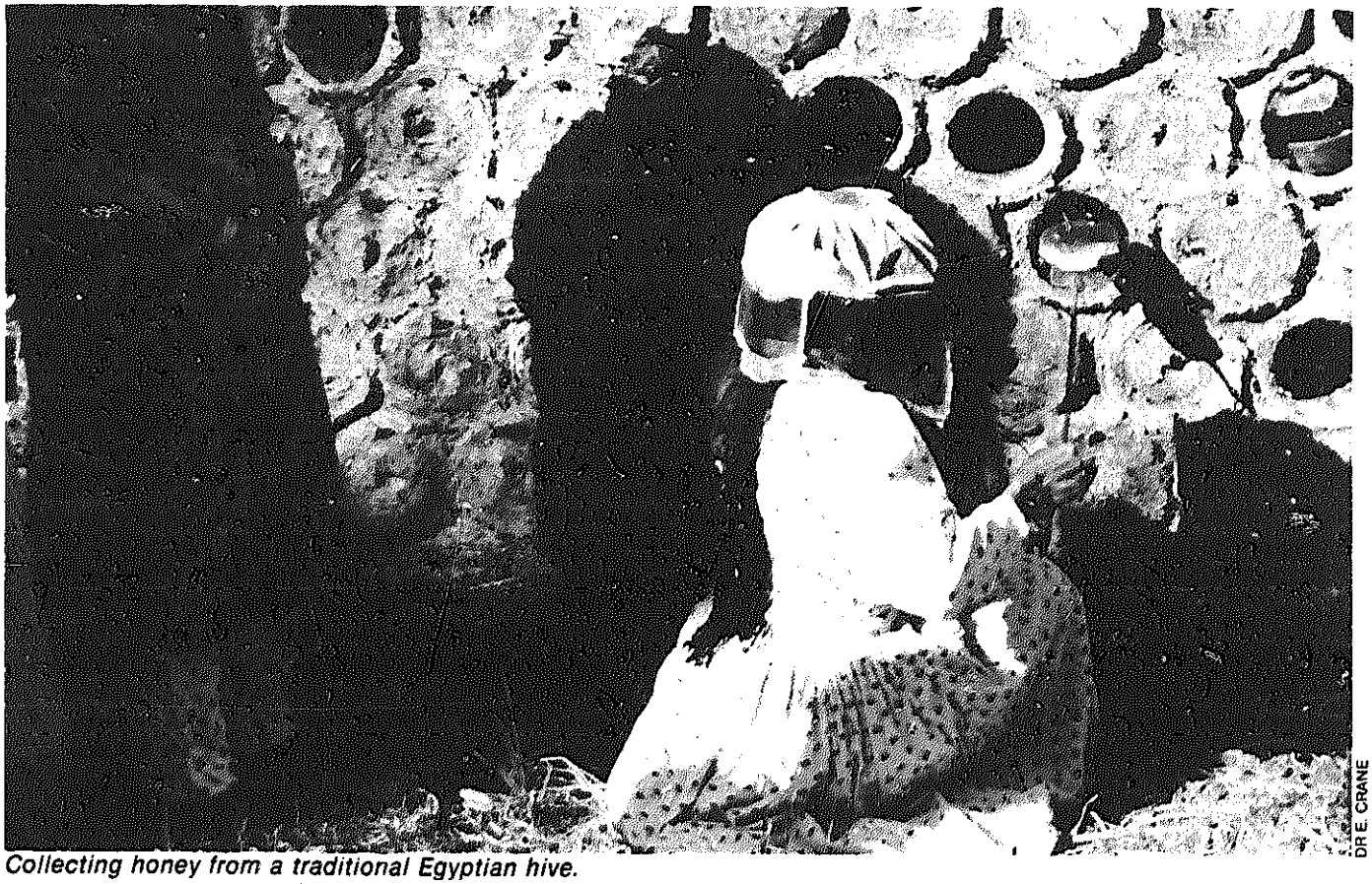


BALE TROLLEYS

Bale trolleys simplify the handling of large heavy wool bales.

ERNEST HAYES (NZ) LTD.
789 Main South Road
P.O. Box 23042, Christchurch 4
NEW ZEALAND

12. BEEKEEPING



DR E. CRANE

Collecting honey from a traditional Egyptian hive.

Throughout history, and in all regions, beekeeping has been a specialized occupation of certain communities or families, remaining a mystery to the population as a whole. This is still true today, although now there are also large commercial beekeeping enterprises, and state and collective bee farms. The range of beekeeping operations in the tropics and subtropics is greater than anywhere else — from primitive honey hunting to some of the largest beekeeping enterprises in existence. Most of the honey exported onto the world market is produced in the subtropics.

Honey production involves both stock rearing (bees) and the handling and processing of food (honey). Widely differing items of equipment are therefore used, at various technological levels. In general a knowledge of beekeeping is necessary in order to understand the design and use of the equipment.

In addition to the different technological levels, beekeeping in the tropics and subtropics uses bees of different species and races, each with its own characteristics. Most beekeepers in temperate-zone countries are familiar only with the European honeybee *Apis mellifera.*

BEES KEPT IN THE TROPICS AND SUBTROPICS

Some beekeeping equipment must be precision-made according to the size of the worker bees. Bees build parallel combs at a precise distance apart, depending on the body size of the worker, and frame hives will not succeed unless they conform to this distance.

European and Mediterranean bees

The most widely used bees in the world are European *Apis mellifera.* Most of the equipment sold, and thus most of the entries in this catalogue, is for use this

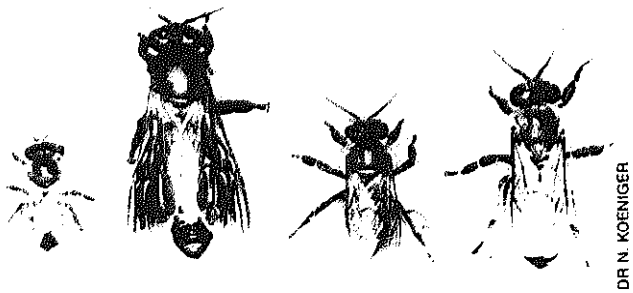
bee. The modern movable-frame hive was developed in the last century for this temperate-zone bee. It was not designed for tropical honeybees, and much time and effort have been wasted in the past by trying to manage tropical bees in the same type of hive, and by the same methods.

Various types of European bees were taken overseas, and their descendants are the bees used in most parts of the New World, where there are no native honeybees. European bees are now widespread in the Americas, Australia, New Zealand, and some of the Pacific islands. In the Mediterranean region — including Africa north of the Sahara — fairly distinct types of *Apis mellifera* are native. Some of them (in Israel, for instance) are now largely replaced by more productive bees of European ancestry. However, except in an isolated oasis or island, such replacement must be a continuing process, since new young queens are likely to mate with native drones, giving hybrid offspring of little use.

African bees

Tropical Africa also has native *Apis mellifera*. They are slightly smaller than European *Apis mellifera*, and their behaviour is notably different. They are more readily alerted to fly off the comb and to sting, and when one bee stings, others are attracted to sting at the same place. Colonies are liable to abscond from their hives if disturbed, and in some areas the colonies migrate seasonally. These are paramount factors governing bee management and hive design.

In Madagascar the native honeybee is a subspecies *Apis mellifera unicolor*, and this bee was introduced in past centuries to islands previously without honeybees, including Mauritius and Réunion. European bees are introduced successfully (and of necessity continuously) into these islands. In the very south of mainland Africa is *Apis mellifera capensis*.



DR N. KOENIGER

Workers of the four honeybee species: from left 'Apis florea', 'Apis dorsata', 'Apis cerana', European 'Apis mellifera'.

Asian bees

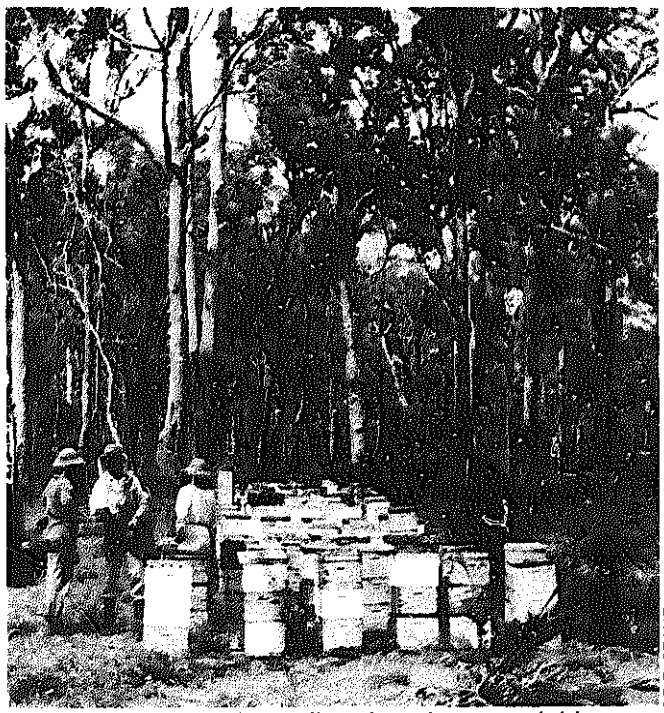
Asia is the most complex continent with regard to honeybees, there being three native tropical species, *Apis cerana*, *Apis dorsata*, *Apis florea*. There are *Apis mellifera* native in the west (Turkey, the Levant, Iran, Iraq, etc.), and European *Apis mellifera* has also been introduced in many places elsewhere. *Apis cerana*, the Asiatic hive bee, looks like a smaller version of *Apis mellifera*. In India and elsewhere it is kept in small frame hives. The size of *Apis cerana* varies more than that of *Apis mellifera*. The smallest are found in parts of lowland tropical Asia, and the largest in the western Himalayas; the latter are about the size of *Apis mellifera*, and European-type hives and fittings can be used for them.

In eastern Asia *Apis cerana* has spread northwards as far as China, Korea, Japan and the Far East of U.S.S.R., i.e. into the north temperate zone. *Apis mellifera* has been introduced into these same regions, and is now used in many agricultural areas where it is much more productive than *Apis cerana*. It is the basis of the beekeeping industries of the countries concerned. Beekeeping with *Apis cerana* tends to be a separate activity, often employing traditional fixed-comb hives and management methods, confined to hill country with native flora, where *Apis mellifera* would not do as well.

Apis dorsata and *Apis florea* build a single comb in the open, and cannot be kept in enclosed hives. Both live only in the tropics of Asia. *Apis dorsata* is the largest of the honeybees; its comb may be a metre or more across, and it yields much honey. The honey is harvested by honey hunters, as described below.

Bees in Latin America

Latin America has seen a great change in beekeeping during the past thirty years. European *Apis mellifera* was used previously, but in 1956 some tropical *Apis mellifera* queens were introduced from South Africa; their offspring hybridized with the *Apis mellifera* already there, and proved dominant over them; they were *tropical* bees, whereas the European bees were not. These 'Africanized' bees have now spread throughout much of South America and well into Central America. They still have the tropical African characteristics, including high 'aggressiveness'. This has altered management practices but has also increased honey yields.



DR E. CRANE

Migratory apiary in Australia, where Langstroth hives are used.

DIFFERENT LEVELS OF HONEY PRODUCTION

Honey hunting

Certain communities in Asia and Africa get much honey by hunting wild nests of honeybees in trees and rocks. In tropical Asia all of the large honey harvest from *Apis*

dorsata is obtained in this way. Honey hunters reach the nests by ladders, or from a rope let down from the top of the cliff above the nests. Although honey hunting is a widespread and hazardous occupation, very little attention has been given to improving the equipment used, and none is on sale as such — so it is not recorded in this catalogue. It may include specially shaped knives to cut the combs out, and appropriate wide containers to catch the pieces of comb and carry them home. A smouldering bunch of twigs, grass, etc., is used to smoke the bees.

Collecting honey from nests of other honeybees (often in trees) is somewhat less dangerous. Combs taken from the nests are put into barrels, gourds or baskets, all locally made. *Apis florea*, whose range extends into China, and as far west as Oman, is used for a primitive form of beekeeping in Oman, but again, no equipment is on sale.

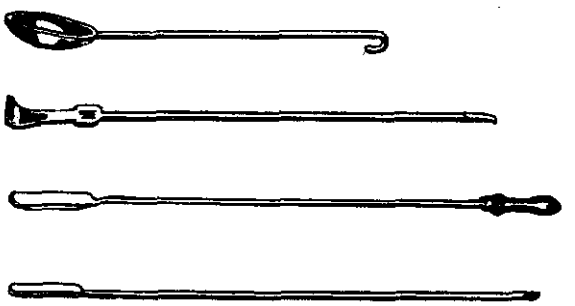
Traditional hives

Tropical Africa has a rich tradition of beekeeping in hives made locally from a log or bark, earthenware, or basketry of various types. These hives often show a high level of craftsmanship, and some communities have developed careful and ingenious methods of taking honey without killing the bees. Equipment is made locally, and there are no 'suppliers'. Log and box hives are used for *Apis cerana* in Asia. There are other fixed-comb hives, usually with no provision for bee management, and therefore needing no equipment purchased from a supplier.

Another group of bees, the stingless bees or Meliponinae, yield modest amounts of honey in tropical America, and to a smaller extent in Africa. The nests are hunted to obtain the honey, as they are also in the tropics/subtropics of Asia and Australia. Particularly in Latin America, the bees have been kept in log and pot hives using methods probably unchanged for centuries, and also in a few 'improved' hives — but these are not stocked by suppliers.

Both honey hunting and traditional beekeeping are carried out with equipment made locally from local materials, at virtually no cost except for the time taken, and following the experience of previous generations. On the other hand, most beekeeping development programmes are based on improved techniques, and on locally manufactured or purchased equipment. They can give much higher yields, but the introduction of high-cost purchases in place of home-made equipment from local materials changes the nature of the enterprise.

Traditional beekeepers may use specialized tools that they cannot themselves produce, for instance knives and other metal implements for removing combs from long cylindrical mud hives. The picture shows a set used with mud hives containing *Apis mellifera lamarckii* in Egypt. Such tools are long-lasting, and a blacksmith would be able to copy them when needed.

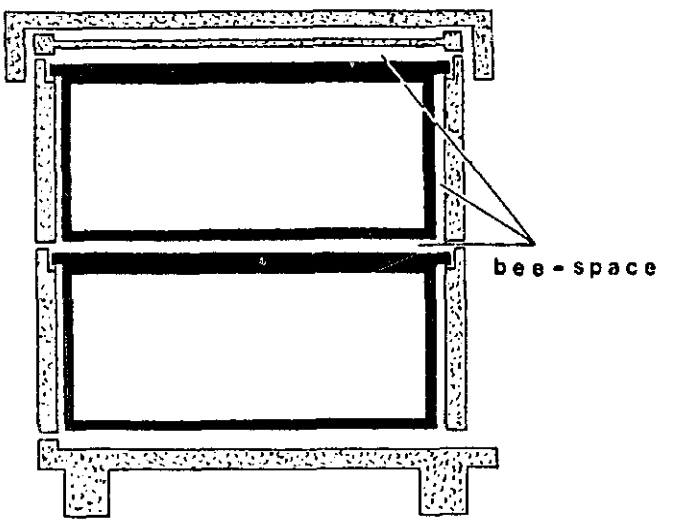


Tools used with traditional Egyptian hives.

Modern movable-frame hives

There is a great gulf between harvesting honey in the traditional ways — whether by hunting or from hives — and 'modern' beekeeping, for which equipment is purchased. Modern beekeeping is based on the movable-frame hive devised by the Rev. L.L. Langstroth in the USA in 1851. This hive was the culmination of much experimentation in Europe and North America during previous decades. It uses rectangular wooden 'frames' to support the combs the bees build. In a natural nest, combs are spaced so as to leave the same distance (a bee-space) between comb surfaces facing each other. The wooden frames are similarly distanced from each other so that combs are separated by a bee-space. They are suspended on 'runners' like files in a suspension filing cabinet. They are movable (i.e. the beekeeper can remove any one frame at will): they are also suitably distanced from the inside walls of the hive, so the bees 'respect' this distance and do not build comb across it. If a larger space is left, bees will build more comb in it; if less space, they will attach the frames to the hive walls.

Nowadays a hive is made up of several superimposed hive boxes, each with its complement of suspended frames, and frames in one box are also distanced from those above and below by a suitable bee-space. Thus each frame and hive box must be made to quite precise dimensions. Each box must fit exactly on to the one below, with no gaps through which bees could enter or leave.



Cross-section of Langstroth movable-frame hive showing bee-space.

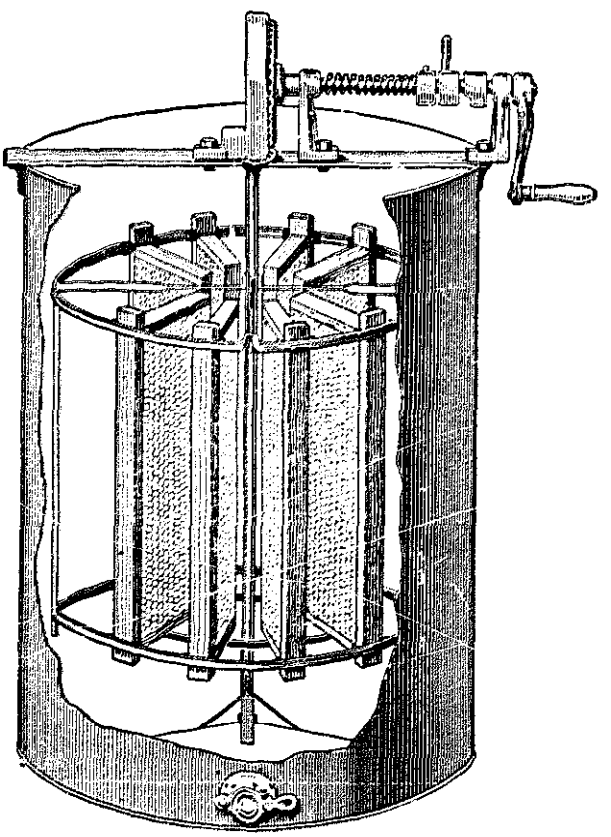
Intermediate movable-comb hives

In the last few decades 'movable-comb' hives have been developed, which are at an intermediate level of technology. Instead of the frames, there is a series of wooden top-bars only, suspended on runners and spaced similarly to the frames. This spacing is the only precision measurement in the hive. The sides of the hive slope inwards towards the bottom. The bees build combs downwards from the top-bars, but do not attach them to the sloping walls. These hives are made as a single,

Intermediate movable-comb hive.

extra-long box accommodating about 30 frames, instead of several movable-frame hive boxes, each holding about 10 frames, and used one above the other.

Another intermediate hive is also a long hive, but it has vertical sides, and is fitted with partial frames (top-bars with end-bars). The partial frames are of a size that will fit a Langstroth hive, so beekeepers can progress from movable-comb to movable-frame beekeeping by transferring their partial frames into Langstroth hive boxes. A few beekeeping equipment manufacturers make these intermediate hives, but otherwise almost the whole of the beekeeping equipment on sale is for movable-frame beekeeping with *Apis mellifera*. This beekeeping is, after all, the basis of the world's honey-producing industry. Movable-frame hives and fittings for *Apis cerana* are on sale in India.



Radial extractor for spinning honey out of the cells in the comb.

PURCHASE OF EQUIPMENT

When equipment should be purchased

Beekeeping is carried out on a small scale (up to 20 hives), medium scale (20-200 hives) and large scale (200-50,000 hives under one control). When thinking in terms of equipment appropriate for different scales of operation, the position is made easier by the fact that *the hive is the unit in beekeeping*. In movable-frame beekeeping the hive box is the unit within the hive. Increasing the scale of the operation requires more hives, and more hive boxes and fittings, more bee suits and smokers, more hives set aside for queen rearing, and so on, but it does not use larger hives. Increasing the honey production per hive requires more frames and boxes for each hive.

Increasing the total honey production directly affects the scale of the honey-handling equipment needed. Whether beekeepers produce 100kg of honey a year or 100 tonnes, they must follow similar procedures in handling it, but the equipment must be appropriate for the amount handled. In general, fairly small-scale equipment is described here, on the grounds that beekeepers who have moved on to large-scale operation are likely to have more knowledge of what is available.

Many users of this catalogue are likely to live and work in areas outside those where movable-frame *Apis mellifera* beekeeping is the rule — or indeed is appropriate. For this reason items in the catalogue are arranged in the following order

- Useful for any type of beekeeping, pages 221, 224: protective clothing, smokers, hive tools;
- Used only in movable-frame beekeeping, pages 222-226: hives and fittings, etc., (movable-comb beekeeping, page 222);
- Used for handling hive products, pages 227-230: honey and beeswax extractors, etc.

Some of the equipment for handling hive products is designed for use with the larger yields obtained with movable-frame hives. But, provided a sufficient quantity of honey or wax is to be processed, much of it could be used for other types of beekeeping.

In beekeeping, benefits from using the more expensive precision-made equipment are based on the fact that such equipment allows more and better *management* of colonies of bees. The modern beekeeper aims to manage his or her colonies so that they do not swarm, and their energy is diverted instead to storing more honey which he or she can harvest.

Advantages of purchasing equipment

Purchase of the equipment listed, from reliable suppliers, has the following benefits:

- The equipment is made in large quantities, using machines that guarantee precision where this is needed.
- The equipment is made of appropriate and well prepared materials (wood, metal, plastic, etc.).
- Some of the materials used are not obtainable in every country. Examples are high quality stainless steel and moulded polyurethane. For the latter, very large numbers of each article must be produced and sold to cover costs.

However, few of the specialist suppliers listed below will be in the same country as the would-be purchaser. It may therefore be necessary to buy a specific piece of equipment from a foreign country. The following are some of the circumstances which would make a

purchase from a foreign country especially useful:

- The equipment is manufactured from materials superior to those available locally, for example from spring steel or stainless steel.
- The design is superior to local design, e.g. honey gates (valves for obtaining a controlled flow of honey from a honey tank, etc.).
- The operation of the equipment depends on critical factors not easily understood from a description, and hence not easily copied by a local manufacturer, e.g. some beeswax processors and pollen traps.
- Manufacture is viable only if large numbers are produced, e.g. moulded plastic honey tanks and containers.
- The precision required, for example for making frames for hives, is not available locally.
- Purchase helps to raise the standard of bee management, e.g. an effective smoker, or to raise the quality of honey and beeswax, e.g. fine-mesh honey strainers.

On the other hand, readers should be warned against purchasing unnecessary gadgets. Some beekeeping suppliers list a few such gadgets to satisfy a local demand — created possibly by publicity in the beekeeping press — but such items do not form part of the basic equipment which is needed everywhere, and their use may waste much time as well as money.

The advantages listed apply to competently run groups and enterprises (including development projects) which have access to capital, revolving funds or loans. They also apply to an individual with some capital, provided he or she has gained enough knowledge to make full use of the equipment, or can be sure of getting instruction whenever he or she needs it. For this individual, acquiring such equipment may be an opportunity to be seized, bringing considerable benefit.

It is different for poor peasant farmers who win their livelihood by using their environment to the best advantage for their crops and animals. A factory-made 'improved' hive of any sort is an alien intrusion in this environment. Unless they can receive constant support in their hive management from outside, they may revert to the familiar hives they made themselves, or they may use the new hive *as though it were* a traditional hive, and thereby forego any benefits from it.

Indicative costs and benefits

Costs vary from country to country, and according to the quality of materials and workmanship — both of which affect the precision which is essential to effective modern beekeeping. The only manufacturer to quote prices for three types of hive (movable-frame, top-bar, and long African), is John Rau & Co. Ltd. in Zimbabwe. A frame hive with brood box and two honey supers (all fitted with frames) is quoted at (Zimbabwe) $50, and a top-bar hive or a long hive at $26. A traditional hive made by the beekeeper from local materials could cost little or nothing.

A competently managed movable-frame hive might yield more or less twice as much honey as a top-bar hive or long hive, and ten times as much as a traditional hive. If the capital and the competence are assured, in many circumstances an upgrading of the level of operation to the most efficient available will give more than a proportionately higher return. If not, then beekeeping even at the traditional level provides extra food, and modest amounts of honey and wax to barter or sell, with virtually no capital outlay.

HEALTH AND SAFETY

Accidents constitute the chief hazard to both beekeepers and honey hunters. In one of the few quantitative studies made, the death certificates of 520 male beekeepers in the U.S.A. were examined, names being obtained from obituary notices. Only one cause killed a significantly higher proportion of the beekeepers than of males in the general population — accidents — which killed 32 of the 520, whereas only 19 would be expected. Many of the 32 died after a road accident, but one suffered fatal burns when smoking his bees, and another was asphyxiated when he used a plastic bag to protect his face from stings. Another cause of accidental death among beekeepers has been poisoning by cyanide when killing wasps' nests, or colonies of bees.

In traditional beekeeping in tropical Africa (where hives are sited in trees for safety), and in honey hunting everywhere, the greatest common hazard may be falling in attempting to reach and work at the bees' nest. In any community that harvests honey from wild nests, a honey hunter's rope is likely to be the strongest one the community possesses.

There is a real need for the development of methods and equipment for reducing the mortality among those who collect honey from *Apis dorsata*, as well as for obtaining cleaner and better quality honey from this bee. It might also be possible to make the honey hunter's lot easier by providing efficient smokers, and effective protective clothing, which would however be very hot.

In at least one area another hazard is responsible for most deaths. Honey collectors in the swampy Sunderbans forest at the mouth of the Ganges in India numbered from 913 to 1495 each year in the years between 1963 and 1972. Of these there were 96 casualties from carnivorous animals, an average of at least 1 per cent a year.

The layman might think that stings would be the chief hazard in beekeeping. But apart from the tiny minority of people who are allergic to bee venom, stings present little hazard to the health of beekeepers. Reactions are limited to local swelling and itching, and even these may be absent. Beekeepers normally acquire considerable immunity to stings, and 20 or even 50 stings on one occasion would not necessarily cause more than temporary inconvenience. The greatest number of stings known to have been received by a person who survived them is 2243; other survivors have received 500 or 600.

In the tiny minority of people who become allergic (hypersensitive), general bodily reactions occur: rash, much swelling, difficulty in breathing, and even unconsciousness. Anyone who suffers a general reaction should give up beekeeping and avoid future situations where he or she might be stung. Medical advice should be sought, and in countries where a desensitization course is available, this should be discussed with a medical specialist.

It is always better to avoid being stung, and protection against stings — especially in the eyes or mouth — is strongly recommended. Protective clothing is the first item of equipment described below.

SOCIO-ECONOMIC IMPACT OF CHANGING THE TECHNOLOGY

Beekeeping development does not need high investment or complicated technology. Simple hives can be made from a variety of natural products which are familiar to the rural populations in different parts of the world. Some are already used for traditional hives. Colonies of bees to populate new hives can be obtained by collecting swarms, or by dividing existing colonies. In some places a subsistence farmer can get a higher income from beekeeping than from all the other work he does during the year. Also, in rural areas with subsistence agriculture, beekeeping raises the social standing of successful beekeepers and, by producing honey, beekeepers broaden the food basis of the population.

Whether it is done to produce food for the family or to provide a cash crop, beekeeping allows great flexibility in the amount of time it occupies. According to the number of hives kept, it can be spare-time, part-time, or full-time. Through the formation of co-operatives, beekeeping can stimulate professional and social contacts for the benefit of an entire group of people.

In its simplest form, beekeeping needs no imported technology or investment. If the technological capability is available, the beekeepers' requirements for hives, honey containers and other equipment can stimulate production by local craftsmen. At higher levels of operation, it may be necessary to import technical equipment for beekeeping, and for processing honey and beeswax.

Where beekeeping becomes a large-scale operation carried out at a modern technological level — with movable-frame hives — it ceases to be a means whereby subsistence farmers can improve their lot through use of local materials and traditional crafts. Capital investment is needed, and labour requirements will probably be minimized in order to increase profits. Honey is produced for sale in the larger towns, or for export (earning hard currency), but the lowest income groups are unlikely to benefit from this.

There is one gain from any increased beekeeping which can benefit the whole rural population. Through pollination, the food-gathering activities of bees improve both the quantity and quality of many cultivated crops. The intensification of agricultural production frequently includes a greatly increased use of fertilizers and

Table 1. The world honey industry, as represented by figures for 13 countries.

Country	1 Colonies × 1000	2 Yield per colony	3 Total honey × 1000	4 Net exports × 1000		5 Honey per capita	6 Sugar per capita
Europe						0.4	45
France	1200	12.7	18.5		− 6.7		
German F.R.	1118	12.6	15.0		−62.9		
U.K.	212	6.3	1.2		−20.8		
North America						0.7	49
Canada	657	51.3	34.8	+ 9.5			
U.S.A.	4275	22.8	93.0		−37.9		
Australia + New Zealand						0.5	57
Australia	405	56.0	21.5	+ 1.1			
New Zealand	191*	30.0*	7.6	+ 2.0			
Latin America						0.1	42
Argentina	1300	25.5	28.0	+29.9			
Brazil	1800	13.3	22.0	+ 0.6			
Mexico	2300	25.5	64.0	+40.0			
Africa						0.26	11
No single country of world importance							
Asia						0.0004	7
China	5700	19.6	100.00	+58.1			
Japan	299	21.4	6.5		−28.1		
U.S.S.R.	8000	23.0	190.0	+16.0		0.5	45
Total	27457		602.1	157.2	156.4		
World total			896.3	214.3	224.7		
% of world represented by the 13 countries			67%	73%	70%		

* from the same source as column 5

Column 1 *Colonies* × 1000 gives the number of occupied hives in thousands in 1983.
Column 2 *Yield/colony* gives the average honey yield in kg per colony, 1979-83.
Column 3 *Total honey × 1000 gives the estimated total honey production for the country in 1983, in 1000 tonnes.*
Column 4 *Net exports* × *1000* gives the country's estimated honey exports *less* honey imports, in 1000 tonnes, for 1982. Figures prefixed by + are net exports, and figures prefaced by − are net imports.
Column 5 *Honey per capita* gives the estimated average honey consumption in kg per capita for the continent as a whole, from sources quoted in E. Crane, *Honey: a comprehensive survey*, published in 1975, but relating to various earlier years. Figures for Africa and Asia are less reliable than others.
Column 6 *Sugar per capita* gives the average sugar consumption in kg per capita for the continent as a whole, from the United Nations Statistical Yearbook (1970); most figures relate to 1969.

pesticides. The latter often kill the population of wild insects that serve as pollinators of cultivated crops. The only remedy is to provide a pollination service, by moving hives of honeybees to the agricultural production areas during the flowering of the crop, and not killing the bees with insecticide while they are there.

SUMMARY OF THE WORLD HONEY INDUSTRY TODAY

Table 1 gives figures for 13 countries. Columns 1-4 are taken from the statistics of the United States Department of Agriculture (*USDA Foreign Agriculture Circular* FS3-83). The totals at the foot of Table 1 show that the data for the 13 countries represent two-thirds to three-quarters of those for the world as a whole, and therefore help to present a world picture.

Table 1 shows high honey yields per colony in Canada and Australia and low ones in Europe. It also shows the high total honey production of the large countries, U.S.S.R., China and U.S.A. (190, 100, 93 thousand tonnes, respectively). The high honey-exporting countries are China, Mexico and Argentina (58, 40, 30 thousand tonnes), and the high net importers are the German Federal Republic, U.S.A., Japan and U.K. (63, 38, 28, 21 thousand tonnes). Until 1981 Japanese imports exceeded those of the U.S.A.

The three largest exporters are thus in the subtropics, and countries in which the European honeybee is not native. All of the four largest importers are comparatively rich countries, and all are in the north temperate zone. Germany and the U.K. belong to the traditional 'bees-and-honey' region in Europe, and the U.S.A. was peopled from this region. Japan, alone, has developed as a honey-eating country since the Second World War. In the final two columns in Table 1, figures for honey and sugar consumption per capita for the continents as a whole are lower for Asia than for any other continent. This situation may change as honey production increases, but only when incomes also rise: Table 1 suggests that purchased honey is now a food of affluent societies.

HOW TO PURCHASE BEEKEEPING EQUIPMENT

Beekeepers can much more easily purchase equipment from a supplier in their own country, if it is available, than from abroad. Beekeepers are urged to try to see a supplier's equipment — if possible in use — and to discuss it directly with the supplier before any purchase is made. In different areas, paramount qualities may vary — for example suitability of hives for hot, dry conditions, maintenance of metal equipment in year-round high humidity, or resistance to termite damage. The following pages are a descriptive, illustrated catalogue of 66 types of equipment. With each description is the name and address of a specialist supplier (if possible one known to manufacture it), or an indication that it can be obtained from most general suppliers.

Some of the general suppliers worldwide are listed below, and further suppliers and manufacturers can be found in the catalogue.

Dr Eva Crane
International Bee Research Association

ARGENTINA

MIGUEL A BREJOV
Nazca 4058/74 (1419)
Buenos Aires
ARGENTINA

EL PANAL
S.A.C.I.F.I.Y.A.
Humahuaca 4229
1192 Buenos Aires
ARGENTINA

MECANIZACION APICOLA SRL
Calle 35, No.407
La Plata (B.A.)
ARGENTINA

TERZA HNOS
S.A.C.I.F.I.Y.A
Floor 5, Corrientes 1312
1043 Buenos Aires
ARGENTINA

AUSTRALIA

JOHN L. GUILFOYLE (SALES) PTY. LTD.
772 Boundary Road, Darra
Brisbane P.O. Box 16
Queensland 4076
AUSTRALIA

FENDER BROS. PTY. LTD.
Elgin Street, P.O. Box 20
Maitland, NSW 23200
AUSTRALIA

AUSTRIA

STEFAN PUFF GmbH
Neuholdaugasse, 8011 Graz
AUSTRIA

BELGIUM

RAYMOND DE BIE
Mechelsbroekstraat 21
2800 Mechelen
BELGIUM

BRAZIL

CAPEL
Parque de Exposiçao de Animais — OPA
Av. Caxanga, 2200
CEP 50 000 Recife (PE)
BRAZIL

PRO-APIS LTD (PROJECTO DE APICULTURA)
Rua Almirante Lamego
38- Edificio Panorama
Caixa Postal 880, Florianopolis (SC)
BRAZIL

CANADA

BEEMAID
625 Roseberry Street
Winnipeg, Manitoba, R3H 0T4
CANADA

F.W. JONES & SON LTD
44 Dutch Street
Bedford, Quebec, J0J 1A0
CANADA

CHILE

CRATE
Casilla 6122, Correo 22
Santiago
CHILE

COLOMBIA

PROAPICOLAS LTDA
Near Pitalito, Huila
COLOMBIA

DENMARK

ØSTJYDSK, BIAVLSCENTER ApS
Vejle Landevej 147 (A 18)
Pjedsted 7000, Fredericia
DENMARK

ANNE MARIE & BERNHARD SWIENTY
Skovbrinken 12
6400 Sønderborg
DENMARK

EGYPT

HASSAN ALLAM
17 Boutrors Street, Tanta
EGYPT

HOUSE OF BEES AND AGRICULTURAL ACTIVITIES
6 Sekket El Manah Street
Opera Square, Cairo
EGYPT

MOHAMED EZZ
7 Army Street, Cairo, EGYPT

FRANCE

APICULTEUR ALPHANDERY
Château de Brignan
84140 Montfavet (Vaucluse)
FRANCE

APICULTURE NEVIÈRE s.a.r.l.
BP 15
Route de Manosque, 04210 Valensole
FRANCE

CAURETTE
139 Rue La Fayette
75010 Paris
FRANCE

EUROPRUCHE
Boulevard De L'Industrie
Z.I. des Loges
53940 St. Berthevin-les-Laval
FRANCE

LEROUGE
91 Rue Mangin
60130 St. Just-Chaussee
FRANCE

MAX MENTHON
36-38 rue du Commerce
74200 Thonon-les-Bains
FRANCE

CHRISTIAN NICOT
Maisod, 39260 Moirans-en-Montaigne
FRANCE

ETS THOMAS FILS SA
65 Rue Abbé Georges Thomas
BP No.2, 45450 Fay-aux-Loges
FRANCE

GHANA

TECHNOLOGY CONSULTANCY CENTRE
University of Science and Technology
University Post Office, Kumasi
GHANA

GREECE

MELISSOKOMIKI
57 Makrygianni Street
Nea Chalkidon, Athens
GREECE

HUNGARY

HUNGARONEKTAR ORSZAGOS
1054 Budapest, Garabaldi u.2
HUNGARY

INDIA

ALL INDIA BEEKEEPERS ASSOCIATION
1325 Sadashiv Peth, Pune 411030
INDIA

EASTERN SCIENTIFIC COMPANY
New B.D. High School
Ambala, Cantt 133001
INDIA

KHADI & VILLAGE INDUSTRIES COMMISSION
Carpentry and Blacksmithy Workshop
Post: Dahanu, Dist. Thane
Maharashtra
INDIA

LOTLIKAR AND SONS
A-1/4 Pioneer Co-op Society
Panvel 410206, Kulaba M.S.
INDIA

PARAGANA BEEKEEPERS CO-*OPERATIVE SOCIETY LTD.*
Post Baraipur, West Bengal
INDIA

RAJ CARPENTRY WORKS
Pathankot, Dist. Gurdaspur
Punjab
INDIA

RAWAT APIARIES (Himalayas)
Ranikhet, Dist. Almore, UP
INDIA

SARVODAYA SAMITI
Gandhinagar, Koraput 764020
Orissa
INDIA

TRIPURA STATE KHADI AND VILLAGE INDUSTRIES BOARD
Post Agartala 799001, Tripura
INDIA

IRELAND

IRISH AGRICULTURAL WHOLESALE SOCIETY LTD.
151-156 Thomas Street, Dublin 8
IRELAND

MIL AN tSULAIN
Cúil-Aodha, Magcromtha
Co. Chorcaighe
IRELAND

ITALY

LEGA SDF
Via de Cresceni 18, 48018 Faenza
ITALY

SAF, s.n.c.
Via Liguria 17, 36015 Schio (VI)
ITALY

JAPAN

AKITAYA HONTEN CO. LTD.
Kano-fuji-machi, Gifu 500
JAPAN

FURUZAWA BEE KEEPING MANUFACTURER
752 Gifu
JAPAN

GIFU YOHO CO. LTD.
Kano-sakurada-cho 1
Gifu-Shi, Gifu 500-91
JAPAN

NONOGAKI APIARY
Oku-machi
Ichinoabuyo-shi, 490-02 Maya
JAPAN

KENYA

MINISTRY OF AGRICULTURE & LIVESTOCK DEVELOPMENT
Beekeeping Branch
P.O. Box 68228 Nairobi
KENYA

MEXICO

MIEL CARLOTA, S.A.
Ap. Postal 161-D
Queretaro III, Cuernavaca, Mor.
MEXICO

MOROCCO

AGRICOLA
34 Rue Beni Amar, Casablanca
MOROCCO

NETHERLANDS

BIJENHUIS
Grintweg 273
6704 AP Wageningen
NETHERLANDS

HONINGZEMERIJ HET ZUIDEN BV
Ladonksemeg 9, Postbus 2
5280 AA Boxtel
NETHERLANDS

H.T. VAN DAM & ZN
P.W. Janssenweg 35-37
8411 XR Jubbega, Friesland
NETHERLANDS

NEW ZEALAND

A. ECROYD & SON LTD.
P.O. Box 5056
25 Sawyers Arms Road
Papanni, Christchurch 5.
NEW ZEALAND

NORWAY

HONNINGCENTRALEN A/L
Østensjøv 19, Oslo 6
NORWAY

PHILIPPINES

IMELDA'S BEEKEEPER SUPPLIES
1910 F. Tirona Benitez Street
Malate, Manila
PHILIPPINES

SPAIN

APICENTER S.A.
Vizcaya 383, Barcelona (27)
SPAIN

VICENTE MENDIPOZO
Avda España 4, Logroño
SPAIN

MIELSO S.A.
Poligono Industrial "El Mijares"
Calle No.7, Apartado 38
Almazora, Castellon
SPAIN

MODERNA APICULTURA SA
La Apartado 9.008, Madrid 28
SPAIN

VICENTE MENDI POZO
Avda Espana 4, Logrono
SPAIN

AUGUST PERPINYA
Carretera L'Hospitalet 45
Cornellá, Barcelona
SPAIN

SWEDEN

OSCAR GUSTAFSSON & CO
Biredskapsfabrik AB
4385 Tofta, 432 00 Varberg
SWEDEN

HEBE STÅL, AB
Fack 32, 684/01 Munkfors
SWEDEN

SWITZERLAND

BIENEN-MEIER
5444 Künten (AG)
SWITZERLAND

U.K.

ROBERT LEE (BEE SUPPLIES) LTD.
Beehive Works
High Street, Cowley
Uxbridge, Middlesex UB8 2BB
U.K.

R. STEELE AND BRODIE
Stevens Drove, Houghton,
Stockbridge, Hants SO20 6LP
U.K.

E.H. THORNE (BEEHIVES) LTD.
Beehive Works
Wragby, Lincoln LN3 5LA
U.K.

U.S.A.

COWEN ENTERPRISES
P.O. Box 396, Parowan, UT 84761
U.S.A.

DADANT & SONS, INC.
Hamilton, IL 62341
U.S.A.

WALTER T. KELLY CO.
Clarkson, KY 42726
U.S.A.

A.I. ROOT COMPANY
P.O. Box 706
623 W. Liberty Street
Medina, OH 44256
U.S.A.

SUNSTREAM
P.O. Box 225
Eighty four, PA 15330
U.S.A.

W. GERMANY

CHR. GRAZE, KG.
Strümpfelbacherstraße 21
7056 Weinstadt 2, (Endersbach)
W. GERMANY

C. KOCH
Hauptstraße 67
7603 Oppenau/Schwarzwald
W. GERMANY

MÜNGERSDORFF
An St. Agatha 37, 5000 Köln 1
W. GERMANY

ERHARD & MARKUS SCHEHLE
8999 Maierhöfen/Allgäu
W. GERMANY

FRIEDRICH WIENOLD
Dirlammer Straße 20
Postfach 15
6240 Lauterbach/Hessen
W. GERMANY

ZIMBABWE

JOHN RAU & COMPANY (PVT.) LTD
2 Moffat Street
P.O. Box 2893, Harare
ZIMBABWE

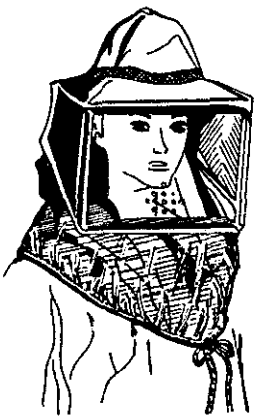
PROTECTIVE CLOTHING

Every beekeeper should have adequate protective clothing, even if he or she sometimes chooses not to wear it all. The most important part to protect is the face, especially the eyes and mouth. Whether arms and hands are covered is a choice to be made by the beekeeper according to the occasion and the work to be done, and the character of the bees to be dealt with. Individual items of clothing *must* be impermeable to bee stings, and every joint between them *must* be bee-tight — if not, it could be safer to strip completely than to risk getting bees caught inside the clothing.

Modern fastening devices such as zip fasteners and Velcro have made it possible for a beekeeper to be completely enveloped in a single garment. Alternatively, separate parts may be used: veil supported by hat or hood; gloves; an appropriate coverall or boiler suit and boots, or cooler body clothes — which, however, will not give as much protection.

Except for the vizor of the veil, which must be black to give good vision, all cloth for garments worn when working with bees should be light in colour and of smooth, close-mesh material. For working with tropical African and Africanized bees, it may be best to use a veil with the outside of the wire-mesh vizor painted white, otherwise bees are likely to fly against the black mesh and obscure vision. With these bees, also, stout plastic gloves may be necessary, although they are hot and clumsy to wear. All general beekeeping suppliers stock protective clothing, but it is worth seeing *and trying on* different types, to find out what is suitable for you and for the conditions under which you work. The outfit shown is one used for working with 'aggressive' tropical African bees.

If, in spite of precautions, you find you have a bee inside your protective clothing, go well away from the bees before you investigate. A similar rule applies to removing the clothing.



HAT AND VEIL

The choice must depend on the type of work to be done, the temperature and wind, and personal preference. The drawing shows a folding veil in which the vizor is made up of 3 rigid sections of black wire mesh. The tapes at the front are tied round the waist in such a way that the bottom edge of the cloth is drawn tightly against the clothes beneath; alternatively the cloth below the veil can be tucked inside a sleeved jacket at the neck. The brimmed hat shown is soft, but a rigid brimmed hat (with ventilation slits if wanted) is preferred by many. The veil may be integral with a cloth hat, or separate, and held over the brim by an elasticated hem at the top.

Woven horsehair or nylon net is used for the vizor in light-weight veils. This is satisfactory, except that in windy weather it may blow against the face or neck.

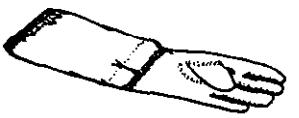
Available from:
GENERAL SUPPLIERS

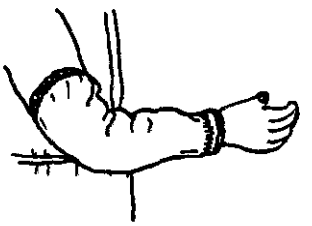
GLOVES AND GAUNTLETS

Gloves (upper illustration) should be light in colour, soft, and sufficiently well fitting to allow the wearer to work delicately when moving frames, etc., in order not to disturb the bees. The material covering the hands should be impervious to stings, and soft leather is ideal; the wider gauntlet part can be of close cotton weave. The upper hem of the gauntlet is elasticated, to be worn over a long sleeve. In no circumstances wear black gloves. Rubber gloves are sometimes advertised, but they are hot and can be clumsy. On the other hand thin cotton gloves are easily penetrated by a bee's sting.

Some beekeepers prefer to wear gauntlets only (lower illustration), in which case the lower hem is also elasticated and fits snugly over the wrist. Either gloves or gauntlets may reach below or above the elbow as required.

Available from:
GENERAL SUPPLIERS





BOOTS

Many beekeepers tuck trouser bottoms into gumboots. They can be purchased at a shoe shop. Alternatively, trouser bottoms are tucked into smooth, light-coloured socks worn with shoes.

You can be stung badly round the ankle through lack of care in ensuring a bee-tight join in the protection there, and bees inside a dark space instinctively run upwards.

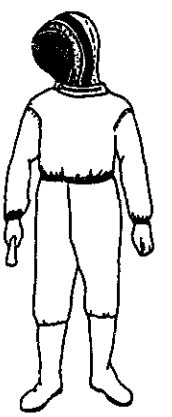
Available from:
GENERAL SUPPLIERS

COVERALL

A standard coverall can be used, of a white close-weave material. Custom-made bee suits incorporate elasticated wrists and trouser cuffs. One maker sells coveralls (illustrated) of rip-stop nylon for working with Africanized bees that sting readily. They are large enough to be worn over clothing and are thin; they are reported to be 'bee-secure' although hot.

These are made by:
Mrs D OLSEN
115 South First East
Providence, UT 84332
U.S.A.

Coveralls (and other such clothing for bee work) should be washable, and washed as often as necessary. This is not only to remove any gross dirt, but to remove odours to which bees might respond by stinging, and to minimize the possibility of carrying disease infection from one apiary to another.

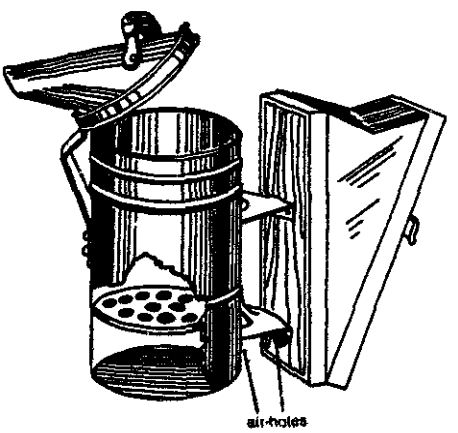


ALL-IN-ONE SUIT WITH HOOD

The drawing shows a two-piece suit, but it can be purchased as a single coverall. The wrists are elasticated. The hood is attached by a zip, (and sewn on at the back of the neck), and can thus be thrown back when not required, without removing the suit. The vizor is of black nylon net, and is kept off the face by nylon boning round the edges and by the self-supporting hood. Garments are made by:

B.J. SHERRIFF
Five Pines, Mylor Downs
Falmouth, Cornwall TR11 5UN
U.K.

By tradition, hoods have been used in certain countries such as the Netherlands, and there has recently been a swing towards them in some other countries. If possible try on a veil with a hood and with a hat, to see which you prefer.



SMOKER

A good smoker is essential in beekeeping with frame hives or top-bar hives. In traditional beekeeping, smouldering twigs or grass are used to smoke bees, but this does not give the directional flow of cool smoke that is most effective, and best for keeping the bees quiet. (The bees respond to the smoke by gorging themselves with honey, and are then less likely to sting.) Some traditional beekeepers and honey hunters would probably find a modern smoker very helpful.

The metal fire box on the left has a directional funnel hinged to the top, which allows the fuel to be inserted. The fuel is kept off the base of the fire box by a perforated metal shelf above an airhole. The bellows on the right, which contain a spring, are used to blow air into the fire box through two holes opposite each other.

The aim is to produce a large and steady supply of cool smoke from the funnel without the need for frequent refuelling. Success depends on the design of the smoker and the use of a large fire box (say 25cm high and 12cm diameter), and on the fuel used. According to what is available, beekeepers use old sacking, decayed wood, wood shavings or other vegetable matter, and corrugated cardboard.

It is important that only smoke, and no flame, should emerge from the smoker, and that the fire should be extinguished immediately after use.

A few suppliers offer a smoker with a clockwork mechanism to maintain a constant flow of smoke, but such a device is not necessary.

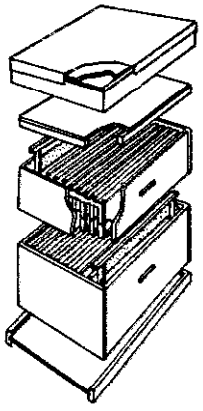
Available from:
GENERAL SUPPLIERS

MOVABLE-FRAME HIVES

MOVABLE-FRAME HIVES FOR 'APIS MELLIFERA'

Types of movable-frame hives that are in wide enough use to be considered appropriate are Langstroth, which is the most widely used throughout the world especially in English speaking countries, and Dadant or Dadant-Blatt. Both these are for the European bee *Apis mellifera*.

In both, the bee-space between hive boxes is at the *top* of each box. This is preferable to a bee-space at the bottom, in which case frames are flush with the hive box at the top. With a top bee-space, a flat wooden cover, (e.g. to support a feeder), can be placed directly on the top hive box. (With a bottom bee-space a cover must have a frame below it to lift it above the top of the frames.) Also with a top bee-space, one hive box can be slid into position on top of the one below without crushing the bees.



LANGSTROTH HIVE

This is the most widely-used hive in the world. The frames are separated from the hive wall (and from each other) by a bee-space.

The illustration on the left is an exploded view of the Langstroth hive, showing the parts in detail (from the bottom): bottom board, brood box or chamber, super or honey chamber, inner cover, roof. Most Langstroth hives have boxes to accommodate 10 frames, but 8-frame and 12-frame hives are also made.

Standard dimensions, and certain details of design, vary slightly from country to country, and it is therefore wise to purchase all hives and hive fittings from one supplier. Langstroth hives are sold by general beekeeping suppliers. In addition, one firm in Egypt specialises in their manufacture, and two general suppliers in India produce them.

MAKHTAR HAMED YASEEN
1 Aziz fahmy Tanta
Garbeya Governorate
EGYPT

ALL INDIA BEEKEEPERS ASSOCIATION
1325 Sadashiv Peth
Pune 411030
INDIA

RAWAT APIARIES
Ranikhet
Dist. Almore
U.P.
INDIA

MODIFIED DADANT AND DADANT-BLATT HIVE

This hive is on a similar principle to the Langstroth, but has eleven deeper frames. They are used very successfully by some large-scale beekeepers. The greater weight of each box when full makes them less generally popular, and the extra size is of no advantage unless bees can be managed appropriately. C.P Dadant, the originator of this hive, was born in France and wrote in the beekeeping press of France and other countries. As a result, a variant of this hive (sometimes known as Dadant-Blatt) is used in many French-speaking countries.

ETS THOMAS FILS SA
65 Rue Abbé G. Thomas
BP No. 2
45450 Fay-aux-Loges
FRANCE

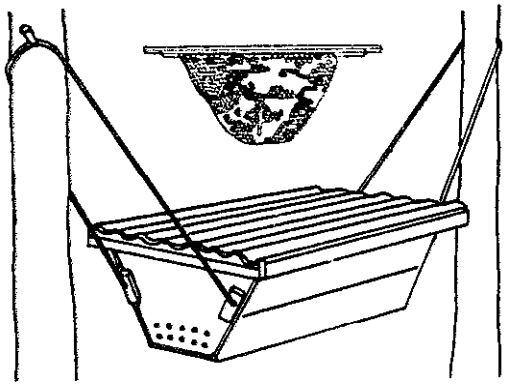
LEGA SDF
Via Armandi 19, 48018 Faenza
ITALY

INDIAN STANDARD HIVE FOR 'APIS CERANA'

Hives on the same principle as the Langstroth and the Dadant-Blatt are manufactured for use with the smaller Asiatic hive bee *Apis cerana*; each hive box usually accommodates 9 frames. Beekeeping suppliers in India manufacture (or supply) these hives.

SEE INDIA GENERAL SUPPLIERS

TOP-BAR HIVES



Top-bar hives are 'movable-comb' hives; they have no frames, but properly distanced top-bars. The bees build combs down from the top-bars, but they do not attach them to the hive walls, which slope inwards towards the bottom.

KENYA TOP-BAR HIVE, FOR TROPICAL AFRICAN 'APIS MELLIFERA'

This design was developed in Kenya before and during the Canadian International Development Agency project (1971-1982). Internal measurements are 88.9 × 44.3cm at the top and 88.9 × 18.9cm at the bottom, height 28.6cm. It has a complement of 28 top bars 3.2cm wide and 48.3cm long, supported by runners. Top-bars touch each other and there is no space between them. This is an important feature when handling tropical African bees, since only one bar-width is open at once, and this can be continuously smoked, so that flight by the bees (and stinging by them) is minimized.

The drawing (above) shows the entrance holes, roof, and suspension method of support — to prevent damage by ants and other enemies.

These hives are manufactured by:

MINISTRY OF AGRICULTURE & LIVESTOCK DEVELOPMENT
Beekeeping Section
P.O. Box 274, 68228 Nairobi
KENYA

They are also sold by:

BROTHER BURKE
Farmer Training Centre, Mola
KENYA

JOHN RAU & COMPANY (PVT.) LTD.
2 Moffat Street
P.O. Box 2893, Harare
ZIMBABWE

The following firm will make top-bar hives to order:
BUDGET BEEKEEPING
Gillbrow Apiaries
Kirkandrews-on-Eden
Carlisle CA5 6DW
U.K.

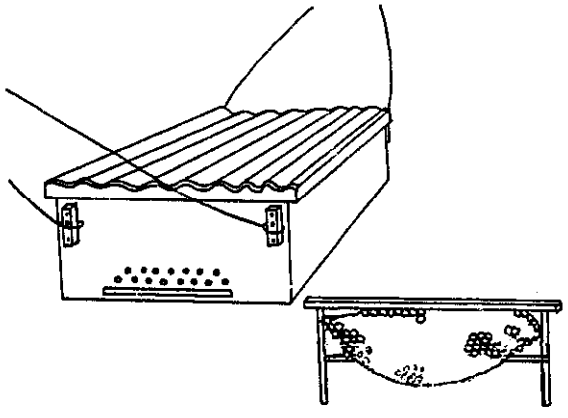
MODIFIED LONG HIVE

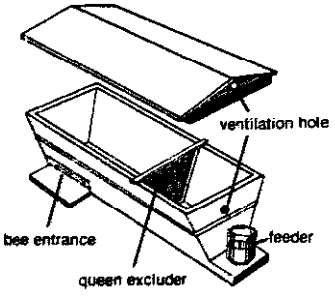
This hive was developed from the Kenya top-bar hive, and has been used there and in Tanzania. The sides are vertical, and each top-bar has 2 end-bars, but instead of a bottom-bar like a frame, a horizontal strut is fixed between the two end-bars; with them, it gives support to the comb. The Kenya top-bars fit this hive, and the partial frames can be used in a standard Langstroth hive, so the 'long hive' provides a useful step in advancing from the top-bar hive to a frame hive.

The hive (below) is supplied by:

For tropical African bees:
JOHN RAU & COMPANY (PVT.) LTD
2 Moffat Street
P.O. Box 2893, Harare
ZIMBABWE

For European bees:
AMERICAN-KENYA RESEARCH AND DEVELOPMENT CORPORATION
1204-2956 Hathaway Road
Richmond VA 23225
U.S.A.





TOP-BAR HIVE FOR 'APIS CERANA'

Several attempts have been made to use top-bar hives for *Apis cerana* in Asia. The hive described here (illustrated left) is two-thirds (linear) the size of the Kenya hive above. It was designed by the late Father B.R. Saubolle, Kathmandu, and is currently being distributed in Nepal under a UNICEF/Agricultural Development Bank programme. It is suspended, for the same reasons as in Africa. It has full-width top-bars, although *Apis cerana* is very little inclined to sting. The slit entrance is taken from an earlier type of the Kenya hive, which was discarded there in favour of a series of holes (as in the Kenya hive above) which the bees can more easily protect.

A strong wire queen excluder is provided with this hive, which is made by:

GANA FURNITURE
Gana Bahal, Kathmandu
NEPAL

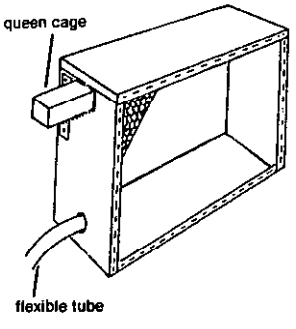
OBSERVATION HIVE

Many beekeeping supply firms manufacture a tall narrow observation hive, in which 2 or 3 frames are mounted one above the other, so that both sides are visible through the glass. These hives are excellent educational aids, but it can be difficult to keep the bees in good condition, especially in hot weather.

The drawing on the right shows a simpler hive in which bees build their own comb from a small piece of foundation (top left of box). The manufacturer below provides detailed drawings and instructions for assembling the hive from the kit supplied.

The hive can be populated with bees from a special travelling box, through the flexible tube (bottom left). The queen is introduced in the queen cage (top left). But do not order live bees except from within your own country.

HERMAN KOLB
P.O Box 183, 737 West Main
Edmond, OK 73034
U.S.A.



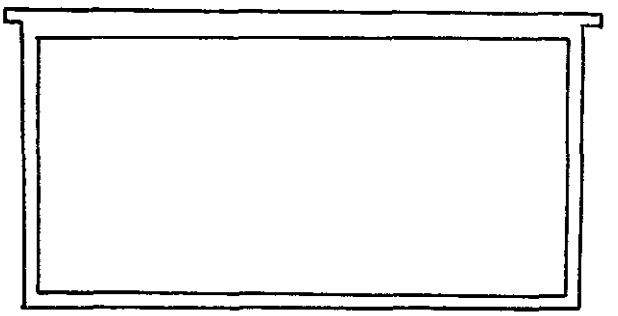
HIVE FITTINGS

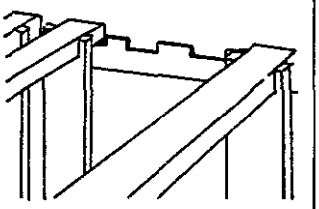
The items featured on this page are for frame hives, and all of them must be of the correct *dimensions* for the hives in which they are to be used.

FRAMES

These support the wax foundation (see p.255) and the comb the bees build from it, and maintain the bee-space gap between frames/combs and hive walls; see Frame spacers. Frames are usually made of fine-grained wood, with tongue and groove or other very strong joints between bottom and end bars, and where the end bars join the top bar. This is necessary because of the weight of honey in full combs, and the strains to which frames are subjected in bee management and in honey extraction. Available from:

GENERAL SUPPLIERS



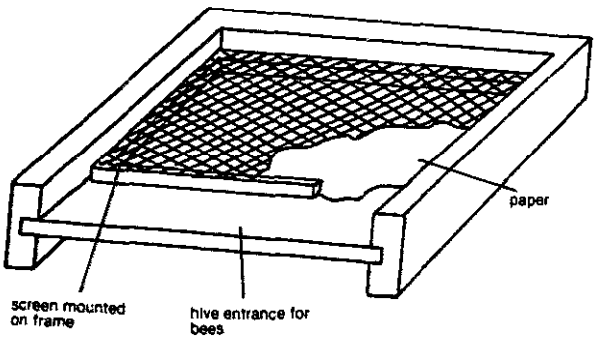


FRAME SPACERS

Some frames are spaced by their end-bars, which are widened out so that when they are touching, the combs are at the exact spacing required. Hoffman is one type. Alternatives are to put a plastic or metal 'end' on each end of the top-bar to space them correctly, or to use 'castellated' metal runners, one type of which is shown above; the frame top-bars fit into the depressions. Bees tolerate a greater variation in cell depth, and in comb spacing, in honey supers than in the brood nest. Castellated spacers are made by several firms, including the two below. The first sells many types, so send full details of what you want.

STOLLER HONEY FARMS, INC.
Latty, OH 45855
U.S.A.

B.J. ENGINEERING
Swallow Ridge, Hatfield
Norton, Worcester WR5 2PZ
U.K.



VARROA DETECTOR

This item is included in view of the publicity given to the spread of the mite *Varroa jacobsoni* to different regions of the world as a parasite of *Apis mellifera*. The drawing shows a device to be incorporated with the floorboard of any frame hive. A plastic grid is mounted above a sheet of white paper laid on the floorboard; dead *Varroa* mites fall on to the white paper and can be seen with the naked eye when the paper is inspected after a dearth period during which brood rearing is minimal.

The plastic grid (to be mounted in a frame that fits inside the hive used, as shown in the drawing) is obtainable from:

S.A.M.A.P.
1 rue du Moulin BP 1
Andolsheim
Neuf-Brisach, 68600
FRANCE

QUEEN EXCLUDER

This is a flat perforated screen, of the same size as the cross-section of the frame hive in which it is to be used. It is inserted above the brood box to separate it from the honey super above, and the slots in it are of such a size that workers can pass through but not the queen. The honey supers are thus kept free from brood.

The dimensions of the slots are critical, and vary according to the type of bee used. For tropical *Apis mellifera* they are smaller than for European *Apis mellifera*, and for *Apis cerana* they are smaller still.

Queen excluders are made in two types: (left) a flat sheet of metal or plastic with slots stamped out by machine; (right) a series of parallel wires soldered to cross-strips, and the whole mounted in a wooden frame. The first is cheaper, but the second is more robust and bees pass through the holes more easily.

Queen excluders must be treated with care. If the grid is distorted it may let a queen through, and is thus useless. Before this fault is discovered, however, a honey super may be half full of brood.

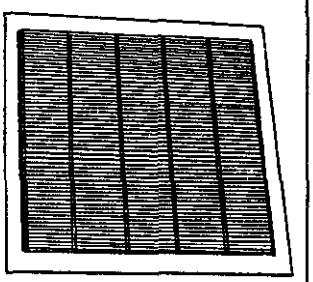
For European *Apis mellifera* the slots should be 4.14mm wide. (For tropical *Apis mellifera* coffee screen can be used.)

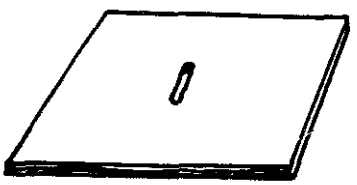
Excluders may be purchased as follows:

plastic sheets, 42.5 × 51.0cm, said to fit 'all 10-frame hives', thickness 0.8mm:
C. ICKOWICZ
Quartier Saint-Blaise
84500 Bollène
FRANCE

metal sheets, many suppliers including:
STEFAN PUFF GmbH
Neuholdaugasse, 8011 Graz
AUSTRIA

framed wire grids, for example:
B.J. ENGINEERING
Swallow Ridge, Hatfield
Norton, Worcester WR5 2PZ
U.K.





BEE ESCAPE BOARD

A 'bee escape' board (left) is the same size as the cross-section of the hive. It is placed on the hive *below* honey supers that are to be removed to harvest the honey, and it contains a device which ensures that worker bees will pass from boxes above it to those below, but not vice versa, so that the supers can be removed empty of bees. Different devices suit different circumstances — according to whether speed of action, certainty that the device will not be blocked by bees, or some other factor is the prime consideration. Any device relying on a spring mechanism can become ineffective if the spring becomes distorted. Nevertheless the Porter bee escape of this type (illustrated right, with the upper part slid back) is the one most commonly sold. The bees 'escape' from above to below by pushing through the gap between two very light springs, but they are unable to return. Multiple Porter escapes are available.

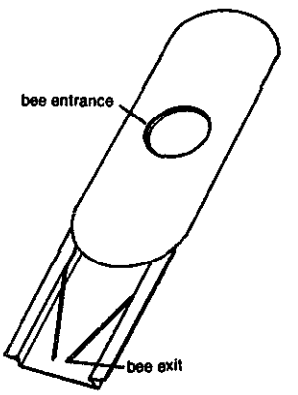
Bees will usually pass through an escape board between one day and the next. They take less time if there are multiple exits. In cool weather they are slow to move. It is *essential* that all honey supers above the escape board are beetight, or they will quickly be emptied by bees from other hives.

An escape board with no moving parts is preferred by many. It incorporates holes so shaped and positioned that bees will enter from above (and so 'escape') but do not enter them from below, to return. Such conical escape boards are sold by:

A.I. ROOT COMPANY
P.O. Box 706
623 W. Liberty Street
Medina, OH 44258
U.S.A.

Porter escapes are available from:

GENERAL SUPPLIERS



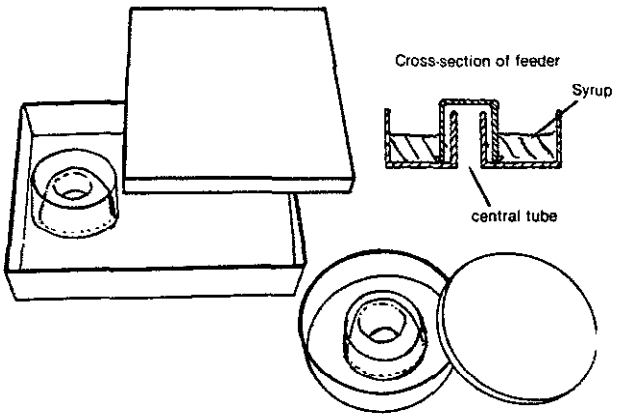
FEEDERS

In most parts of the world it is necessary to make provision for feeding sugar syrup to bees — for instance to counteract some unexpected adverse weather, to build up a small nucleus made in order to increase the number of colonies, or to encourage a swarm, or other bees newly put into a hive, to remain there.

Feeders are placed: at the top of the hive above the top box occupied by bees; or inside the hive with the bees (in the form of a 'dummy' frame); or outside the hive with an entrance only from inside. Larger feeders are preferable for food that the bees must store for a dearth period. When it is important that the bees take the syrup immediately, a 'dummy' frame type is good.

Other materials are used for feeding bees, apart from honey of which an adequate supply should be left in hives as a matter of course. Combs of honey from another source may be used in the hive, but it must be checked that they do not come from a diseased colony. Dry sugar can be fed instead of syrup in warm weather, spread over the inner cover of the hive; it needs no special feeder. Dry sugar feeding will not lead to robbing, which syrup or honey feeding can do if other bees have any access to the food (most usual with an outside feeder).

Pollen and/or pollen substitute is fed by beekeepers in some areas where pollen supplies are deficient, but this also needs no special feeder.



FLAT TOP FEEDER

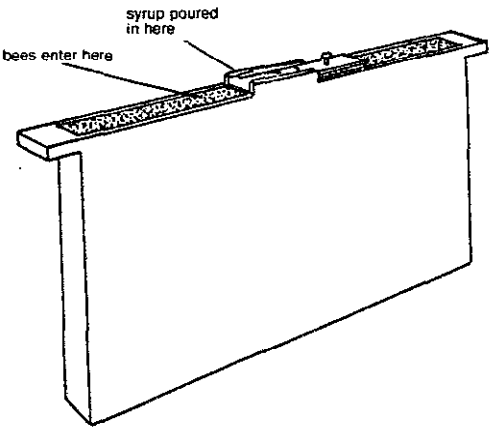
The drawings on the left show a large square feeder (the size of the hive cross-section) and also a smaller round feeder. Both have a central tube through which the bees enter from below, and a provision for them to have access to the syrup by walking down the roughened outside of the tube. An outer cylinder closed at the top prevents them from getting access to, or drowning in, the bulk of syrup.

The feeders shown are of plastic: the square one fitting the Dadant-Blatt hive is from:

LEGA SDF
Via Armandi 19, 48018 Faenza
ITALY

Round feeders are widely available.
A square plastic feeder of intermediate size can be obtained from:

R. LORHO
Saint-Loup, 28360 Dammarie
FRANCE



DUMMY FRAME FEEDER

This is sometimes called a division-board feeder. It conforms to the size of the frame-plus-comb in the brood box, where it replaces a complete frame. The bees enter from the top, and inside there is a float or some other provision to protect the bees from drowning in the bulk of the syrup. This feeder is safe from robbing, and its contents are quickly available to the bees, but the hive must be opened to fill it. The feeder shown is of plastic, for Langstroth hives, and is sold by:

OLIFIN PRODUCTS
P.O. Box 10217, Te Rapa
NEW ZEALAND

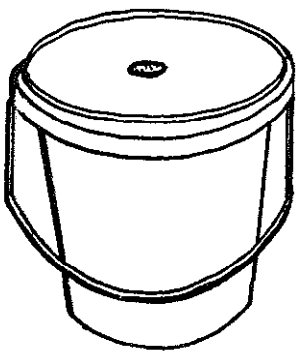
Another feeder of a similar type is obtainable from:
STANDARD
Kifisias 75, N-Iraklion
Athens
GREECE

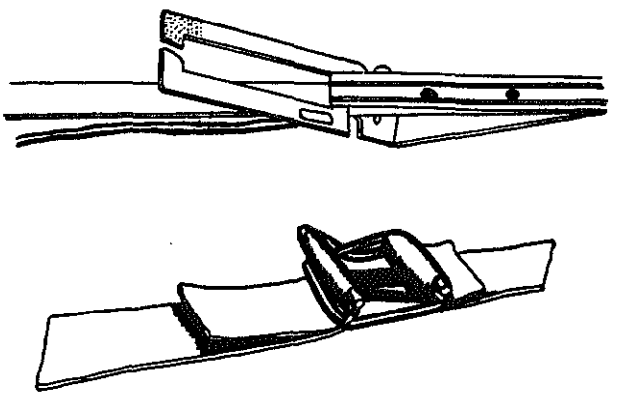
PLASTIC PAIL

The plastic pail shown below has a tightly fitting press-on lid, with a fine-mesh insert at the centre. It is filled with syrup (4.5 litres) and inverted over a feed hole in the top cover of the hive.

The pail shown is sold by:
A.I. ROOT COMPANY
P.O. Box 706
623 W. Liberty Street
Medina, OH 44258
U.S.A.

Many beekeepers use, instead of a special feeder, an inverted friction-top metal honey tin/can/pail that holds 2kg or 5kg of syrup, and these can be purchased from almost any beekeeping equipment supplier. Two or three holes are punched at the centre of the lid, using a nail (jagged side inside the pail). More holes can be used, but if they extend all over the lid, the syrup is liable to leak out when the can is inverted over the colony.





DEVICES FOR SECURING HIVES FOR TRANSPORT

Frame hives are often transported by truck from one honey flow to another. It is essential that all hive boxes, and cover and floorboard, are fastened together so that they do not slip apart and let bees escape. Ventilation for the bees is also essential, and the lid of the hive is usually replaced by a perforated metal screen. The drawing shows two types of buckles for rayon/nylon straps to put round the hive; styles sold by general *suppliers vary from country to country.*

Apart from tightly secured straps, various metal devices are sold for permanent fitting to the hive boxes, with a closure to be applied before moving which locks the hive together; not all are suitable for large-scale operation. Large metal pointed staples are sometimes knocked into the boxes, but they cause damage and are not be be recommended.

Available from:
GENERAL SUPPLIERS

HIVE TOOL

The name 'hive tool' is given to a strong metal bar (usually of high quality spring steel) about 20-25cm long, which is shaped at the two ends in special ways. One end, often bent at right angles to the bar itself, is broad and with a sharp edge; it is used for scraping wax or propolis (a sticky resin bees use as a building material) off a wooden surface. For good leverage in loosening e.g. frames or top-bars, the other end is made narrower, or it may be specially shaped, for instance as shown in the upper drawing. A hive tool is useful for separating hive boxes, and is kept constantly at hand when inspecting hives. Any general beekeeping supplier sells hive tools, and it is worth trying several in your hand to see which suits you. The two on the left are made by:

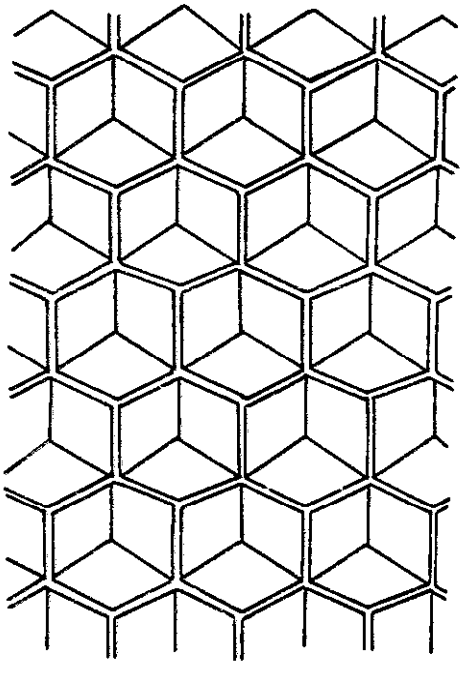
MAXANT INDUSTRIES INC.
P.O. Box 454
Ayer, MA 01432
U.S.A.

FOUNDATION AND COMB

This section covers both comb foundation and the equipment for making it. The cell size is critical for both foundation and comb, so different types of bees are dealt with separately.

Foundation is made of beeswax. A mixture of other waxes presents problems when combs are finally melted down and the beeswax recovered. For the use of plastics, see plastic frames (below right).

The diagram below shows (enlarged) the pattern of hexagons pressed into a flat sheet of beeswax when it is made into comb foundation.



BEESWAX FOUNDATION FOR EUROPEAN 'APIS MELLIFERA'

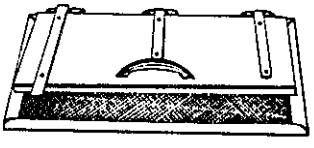
This is obtainable from almost any general beekeeping supplier where *Apis mellifera* is used. In North America most foundation is sold with strengthening wires embedded in it; elsewhere some beekeepers embed the wires themselves, securing them to the frame in the process. In Asia, both worker and drone foundation is manufactured by:

IMELDA'S BEEKEEPER SUPPLIES
1910 F. Tirona Benitez Street
Malate, Manila
PHILIPPINES

FOUNDATION DIES

These provide the least expensive way of making foundation on a small scale. Molten beeswax is poured into a 'forming tray' to form a thin sheet, and the sheet is laid between a pair of matched dies (plastic sheets embossed with the hexagon shape of cell bases, shown on the left). The 'sandwich' is passed through a wringer or under a heavy roller. Alternatively, an oil drum filled with wet sand, or sand and water, can be rolled over the 'sandwich' which has been laid carefully on a flat board. The hinged plastic dies are sold in two sizes, 28 × 43cm for Dadant frames and 23 × 43cm for others, with cell size for worker or drone. The tray is manufactured by:

H.T. HERRING & SON
14 Severn Gardens, East Oakley
Basingstoke, Hants. RG23 7AT
U.K.



MOULD FOR MAKING EUROPEAN 'APIS MELLIFERA' FOUNDATION

The mould for making European *Apis mellifera* foundation is heavier than the embossed plastic dies (see above) but is more straightforward to use. Molten beeswax is poured onto the lower die, which constitutes the base of the tray, and the hinged lid (upper die) is closed on to it. One manufacturer of such a mould is:

LEAF PRODUCTS
24 Acton Road, Long Eaton
Nottingham NG10 1FR
U.K.

ROLLERS FOR MAKING EUROPEAN 'APIS MELLIFERA' FOUNDATION

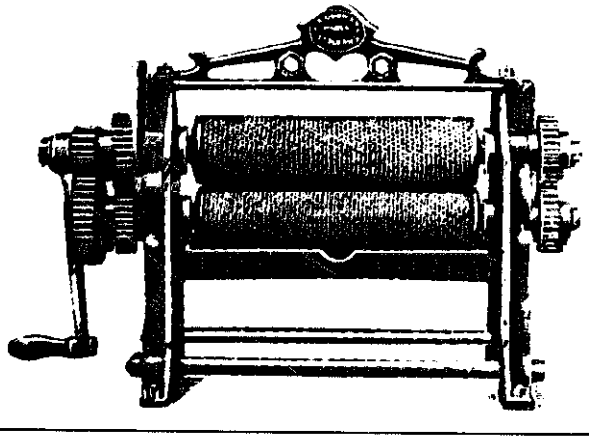
A previously formed long strip of beeswax sheet is passed between two rollers embossed to serve as dies for the foundation. (The long strip has been obtained by using a pair of plain rollers).

Three suppliers are:

ROGER DELON
83 Route de Grand-Charmont
25200 Montbéliard, (Doubs)
FRANCE

CHR. GRAZE KG.
Strümpfelbecherstraße 21
7056 Weinstadt 2, (Endersbach)
W. GERMANY

BERNHARD RIETSCHE
Bienengerätefabrik
7616 Biberach/Baden
W. GERMANY



PLASTIC FRAMES WITH INTEGRAL COMB (FOR 'APIS MELLIFERA')

Many plastic frames with integral plastic foundation (or alternatively comb) are produced. They are suitable for large-scale beekeepers, and benefits include greater strength when extracting honey at high speed, ease of sterilization, and saving of time used in assembling wooden frames.

In many conditions bees seem to prefer beeswax to plastic in comb or foundation, when both are used. If plastic is tried, it should be during a good honey flow, and *all* frames in a super should be plastic. Frames used successfully, with integral foundation on which the bees build combs are Pierce Plastic Frames, made by;

PIERCO INC.
1495 W. 9th Building
501 Upland, CA 91786
U.S.A.

BEESWAX FOUNDATION FOR TROPICAL AFRICAN 'APIS MELLIFERA'

The cell size for these bees is quoted as 1050 cells/sq dm. The following firm is believed to supply suitable foundation to this specification:

JOHN RAU & COMPANY (PVT.) LTD.
2 Moffat Street
P.O. Box 2893, Harare
ZIMBABWE

FOUNDATION MOULD
Manufactured by:
LEAF PRODUCTS
24 Acton Road, Long Eaton
Nottingham NG10 1FR
U.K.

FOUNDATION ROLLERS
Manufactured by:
TOM INDUSTRIES
P.O. Box 800
El Cajon, CA 92022
U.S.A.

BEESWAX FOUNDATION FOR 'APIS CERANA'

The following firms are believed to supply suitable foundation:

IMELDA'S BEEKEEPER SUPPLIES
1910 F. Tirona Benitez Street
Malate, Manila
PHILIPPINES

RAWAT APIARIES (Himalayas)
Ranikhet, Dist. Almore, UP
INDIA

FOUNDATION DIES
No foundation dies or moulds are known to be on sale. Matched dies like those for *Apis mellifera* (see above) would help many beekeepers in Asia. The initial production of the form from which dies are made is very expensive, and the manufacturer would need either to be assured of a large number of orders, or to receive some financial support, before he or she could produce these dies.

FOUNDATION ROLLERS
Manufactured by:
TOM INDUSTRIES
P.O. Box 800
El Cajon, CA 92022
U.S.A.

BEESWAX FOUNDATION FOR 'APIS FLOREA'

The firm below made (to order) rollers for *Apis florea* foundation, to fit their own foundation mill. They also supplied wax-melting tanks, and rollers for making the preliminary wax sheets.

LOTLIKAR AND SONS
A-1/4 Pioneer Co-op Society
Panvel 410206, Kulaba M.S.
INDIA

QUEEN REARING

Queen rearing can be a profitable undertaking, both in financial terms and in improvement of colony performance and ease of handling. It must be done to a strict pre-planned timetable. Since queens mate in the air, no control over the male line is possible, except in isolated mating apiaries, or by using instrumental insemination. All equipment here is for European *Apis mellifera*, but most could be used or adapted for other bees.

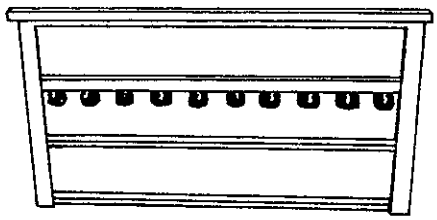
One specialist firm is:
CHRISTIAN NICOT
Maisod, 39260 Moirans-en-Montaigne
FRANCE

GRAFTING TOOL

For transferring a young larva into a cell cup (see right), operators may use something to hand, for instance a pointed piece of yucca or other leaf. Alternatively they may prefer a specially shaped blunt 'needle' with a handle that allows them to work comfortably but with care and precision.

Grafting requires patience, good eyesight, and steady hands, but no bookfearning.

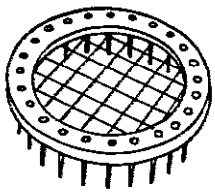
Available from:
GENERAL SUPPLIERS



CELL CUPS AND FRAME

The larvae are grafted (see tool left) into artificial 'cell cups' (right) with a supply of royal jelly, and the cups are often mounted on 3 horizontal bars fixed between the end bars of a frame which contains no foundation, 10 to each. The frame is inserted in a strong queenless colony of bees.

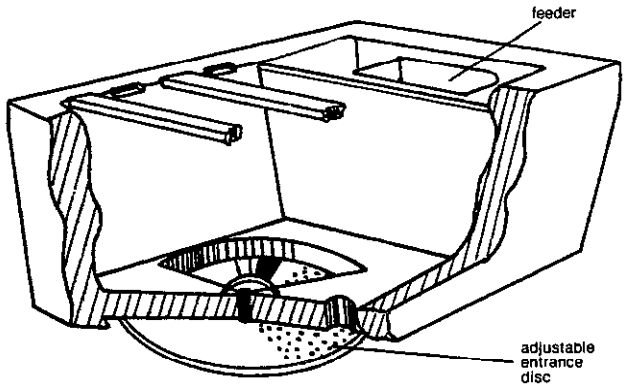
GENERAL SUPPLIERS



QUEEN MARKING

A queen bee may be marked for identification by gently placing the fine threads of a press-in cage over her on the comb. A spot of quick-drying paint is then placed on the queen's thorax. Or tiny coloured discs may be stuck on; these are either numbered, or are made in the 5 colours of the international code for queen marking.

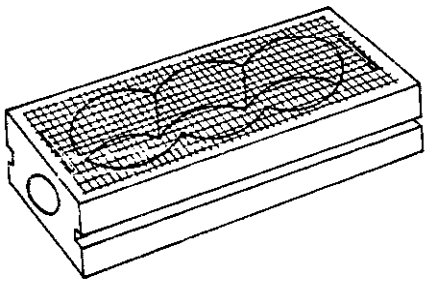
Available from:
GENERAL SUPPLIERS



MATING HIVE

After the queen cells are sealed, each is put into a small mating hive. The queen will shortly emerge and fly out to mate with drones in the air when a few days old. The mating hive can be like part of a brood box, containing 2 or 3 frames. Or it can be a tiny hive (as illustrated) which uses fewer bees. Queens are likely to mate more quickly from a small hive. Such hives are often of polystyrene, which provides better heat insulation than wood. They contain 4 top-bars from which the bees build sufficient comb to allow the queen to start laying. A feeder is provided. The model shown is fitted with an adjustable entrance at the bottom, and may be suspended for safety. Mating hives can be purchased from many suppliers; illustrated is that from:

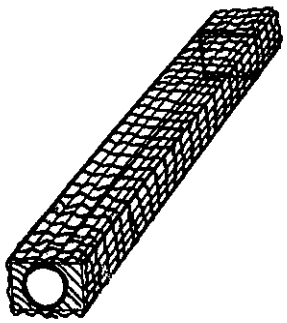
R. STEELE AND BRODIE
Stevens Drove, Houghton
Stockbridge, Hants SO20 6LP
U.K.



QUEEN MAILING CAGE

The queen rearer uses this type of cage for sending queens to the purchasers. The cages are made by drilling into a small solid block of wood, and one hole is filled with candy to provide food for the queen and attendant workers in transit. One side of the cage is of wire mesh to allow ventilation.

Available from:
GENERAL SUPPLIERS



INTRODUCING CAGE

The introducing cage is thin, to be slipped into the space between two frames. Dimensions of the cage shown are 89 × 19 × 13mm: the wire gauze leaves holes about 3mm across. These are as wide as possible because workers of the new colony must have direct physical contact with the queen in the cage, so that pheromones* can pass between them. It is then more certain that she will be accepted by the colony. The queen is inserted into this cage without food, and the bees feed her through the gauze. In some types of cage the mesh is too small. (The workers that travelled with her are removed and killed beforehand; they can be of no benefit, and might possibly carry a new disease infection into the colony.)

*Substance produced by insects and animals for detection and response by others of same species.

Available from:
GENERAL SUPPLIERS

APPARATUS FOR INSTRUMENTAL INSEMINATION

Methods for insemination of the queen with drone semen have been so well developed that they are now routine in some countries. But the apparatus required is expensive, and it is a waste of time and money to purchase it unless (a) a properly controlled selection programme can be used for bee breeding, and (b) it will be more beneficial to use instrumentally inseminated queens than naturally mated ones. The apparatus is not sold by many general beekeepers' suppliers, but the first address listed is one of the few that does and they also sell an excellent set of 111 full-colour 35mm slides with a printed manual based on them, taking the operator through every stage of the process.

DADANT AND SONS INC.
Hamilton, IL 62341
U.S.A.

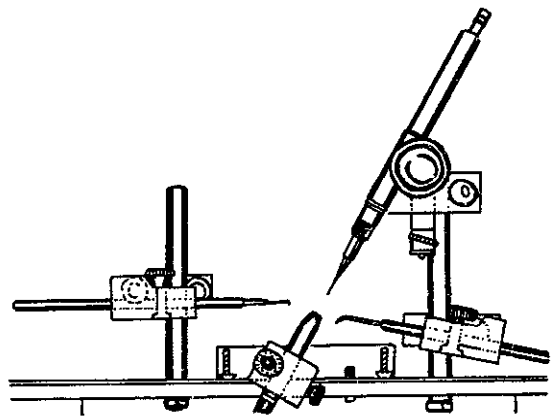
APISMAR
Calle 40 no.492
La Plata, B.A.
ARGENTINA

CHIRANA, EXPORT-IMPORT
92175 Piestany
CZECHOSLOVAKIA

J. HAIDINGER
Finkenweg 5, 8042 Schleissheim
W. GERMANY

HESSISCHE LANDESANSTALT FÜR LEISTUNGSPRÜFUNG
Aussenstelle für Bienenzucht
Erlenstraße 9, 3575 Kirchhain
W. GERMANY

W. SEIP
Hauptstraße 34-36
6308 Butzbeck-Ebersgöns
W. GERMANY



REMOVING HONEY FROM THE HIVE

The bees must first be made to leave the honey supers. This can be achieved by brushing and shaking them off the individual combs, or by using an 'escape board' (see Hive Fittings, p.223). Alternatively the bees can be driven from the supers down into the brood chamber by using a 'fume board' to apply a bee repellent, or the supers can be taken off the hive and the bees blown out with a 'bee blower'.

An escape board involves two visits to the hive, one to insert it and another to check that the supers are bee-free, and then to remove them. The other methods need only one visit, but they disturb the bees more. It is therefore best to work late in the day, when flight activity is decreasing, to reduce the chance of subsequent robbing of honey by bees from other hives. If robbing seems to be occurring, it can be helpful to apply a fine spray of water to the hive fronts, or wherever bees are congregating — by reducing the temperature this makes the bees less active.

FUME BOARD

This is a shallow box or tray made of insulating board such as pressed fibre — of the same cross-section as the hive. The internal depth of the tray is important and depends on the volatility of the repellent sprinkled on it. At temperatures above 27°C an insulated cover is helpful, to prevent heat from the sun vaporizing too much of the repellent. For benzaldehyde (artificial oil of almonds) a depth of 5cm has been recommended. After sprinkling benzaldehyde on the inside of the fume board, this is inverted over the (uncovered) top super; a white cloth on top of the board will prevent too rapid evaporation. After a few minutes the bees should have left the top (shallow) super; benzaldehyde is not effective with a full-depth hive box. The super is then removed, and if necessary the fume board is placed similarly on the one below, and so on.

If many supers are to be removed from a heavily populated hive (and especially if some of the honey is unsealed), increasing difficulty may be encountered with successive supers, since more and more bees are being crowded into a smaller space. (One commonly held objection to the use of any repellent is possible contamination of the honey, but this applies much less to benzaldehyde, which is used as a food flavouring, than to carbolic acid which was used earlier as a bee repellent.)

Available from:
GENERAL SUPPLIERS

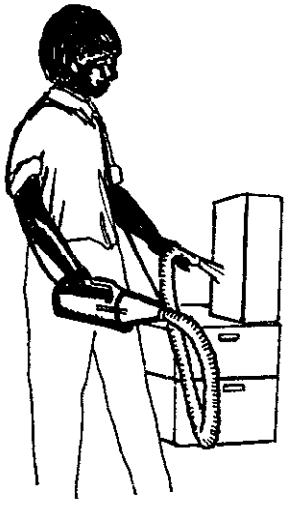
HONEY PROCESSING

All previous operations have been on bees or hives. When starting to do work on honey, it is important to remember that honey is a food, and that appropriate standards of hygiene must be maintained. Also, bees not only make honey; they quickly get the scent of any honey left unguarded, and collect it to take back to their hives. This can happen in an astonishingly short time. So from the moment the honey combs free from bees are taken off the hive, *they must be in a beetight building or enclosure.*

Uncapping and extracting (by whatever method) must be done in a room that allows no access to bees. A few bees may be brought in on clothes or on combs, so vents that allow bees to fly out of the room but not to re-enter are helpful. There is one exception to the above rule: if a good honey flow is still in progress, the bees may continue to work it and ignore the honey being dealt with.

Bees in the honey house are objectionable from a hygienic point of view, because when they fly round trying to escape, they release excreta on to walls and floor and this is unacceptable in a food-processing area.

In the simplest operation, pieces of honeycomb are placed in a cloth, which is hung up and left for the honey to drip out (this is 'run honey', the best), and then squeezed to force out as much as possible of the remaining honey.



BEE BLOWER

Unlike smoke or a bee repellent, an airstream used to blow bees out of a hive does not introduce any possibility of honey contamination.

A bee blower is normally powered from an electricity supply, but one could be devised to be operated by some other form of power. It is rather like a vacuum cleaner in reverse, and is used by standing a super (open above and below) either on top of the hive (as shown) or on a stand constructed like a sawing horse, placed just in front of the hive. The bees blown out of the super find their way back to the hive entrance. The blower shown operates on 110V, and is made by a specialist firm:

SOUTHWESTERN OHIO HIVE PARTS CO.
Monroe, 629 Lebanon Street
OH 45050
U.S.A.

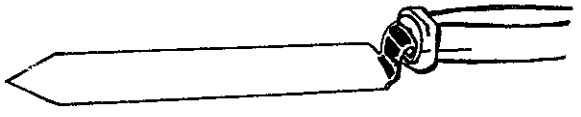
UNCAPPING HONEY COMBS

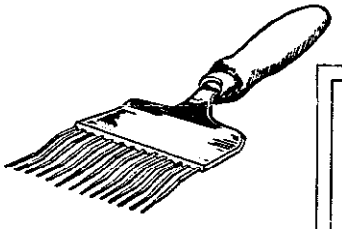
Framed combs of honey taken from the hive must be uncapped (to remove the wax seals) before they are put in an extractor (see below).

UNCAPPING KNIFE

The knife shown here is of a standard type. The essential features are (a) that the knife is longer than the depth of the frame, and (b) that the handle is offset for convenience in use. The knife can be heated by standing it in hot water. Often two knives are used, one being heated while the other is used.
Available from:

GENERAL SUPPLIERS





UNCAPPING FORK

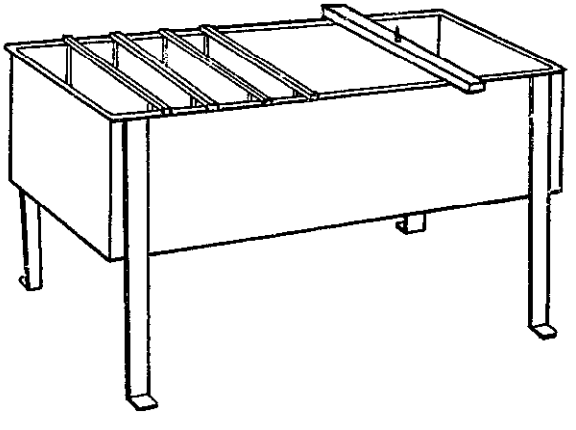
These are of various widths, and many of them are narrower than the depth of a comb. They are operated by sliding the fork under the cappings from one end of the comb to the other. The narrow forks are useful when the shape or surface of the comb is irregular. The fork in the drawing (above), with offset tines, is made by:

BLOSSOMTIME
P.O. Box 1015
Tempe, AZ 85281
U.S.A.

UNCAPPING TRAY

An uncapping tray below is used to catch the capoings and honey that fall from the comb as uncapping proceeds. It is convenient (but not essential) to use a custom-made tray, which has a sheet of wire mesh near the bottom through which the cappings drain. The frame is held firm by an upward pointing projection on the cross bar. General suppliers sell various types of uncapping tray, some with additional features, which suit individual preferences.

Available from:
GENERAL SUPPLIERS



HONEY EXTRACTORS

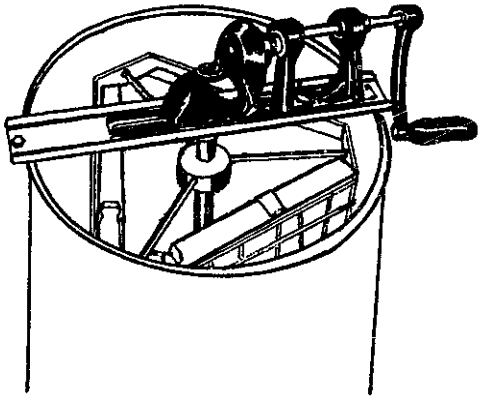
These operate by centrifuging the honey out of the combs. The extractor is a cylindrical container with a centrally-mounted fitting that supports combs or frames of uncapped honey, and a mechanism that rotates the fitting (and the combs) at speed. The honey is thrown out by centrifugal force to the inner wall of the extractor, whence it falls by gravity to the bottom. Very near the bottom a honey gate (see over) is fitted, allowing the honey to be drained out when required. A free space is left below the frames so that a certain amount of honey can accumulate, but honey must be drained off before it reaches the supports of the frames.

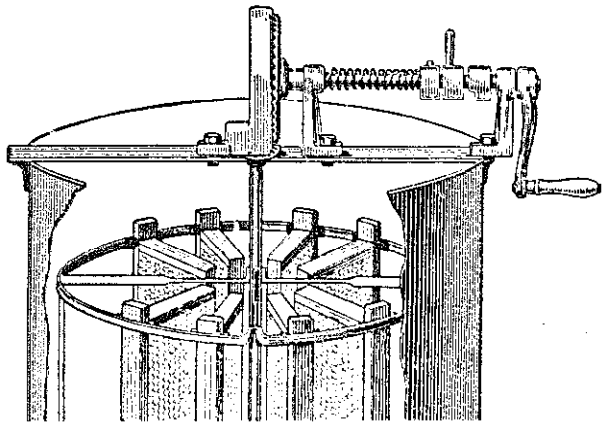
The temperature of the room is very important when extracting honey from the combs, because honey flows very much more quickly when warm than when cold, and less is left in the cells. Also, if high speeds have to be used to force the honey out, the combs are more liable to break. With very high-speed (electrically operated) extractors, the speed has to be increased gradually to prevent damage to combs.

TANGENTIAL EXTRACTOR

This was the first type to be developed, and is still much used, especially in small-scale beekeeping. The axis is vertical, and framed combs (often 2, 3 or 4) are supported in baskets, or against vertical grids, arranged tangentially, i.e. at right angles to the radius. The frames must normally be spun twice, once with each of the two sides outermost. Some tangential extractors are self-reversing. These extractors can be obtained from almost any general supplier. A firm that specializes in well made honey extractors is:

MAXANT INDUSTRIES INC.
P.O. Box 454
Ayer, MA 01432
U.S.A.





RADIAL EXTRACTOR

A radial honey extractor is like a tangential one, except that the frames are placed radially. The cylinder is larger, and is often made to hold the frames from one honey super (9 or 10) or a multiple of this number. Frames are placed with the top-bar outwards. More power is needed to operate these extractors, and large ones are electrically operated, but a 9 or 10 frame extractor can be operated by hand, or by foot using an adapted bicycle mechanism. Only one spinning is needed.

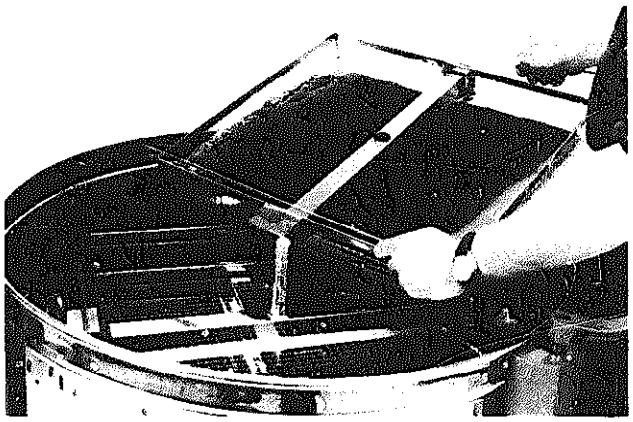
Available from:
GENERAL SUPPLIERS

HONEY GATE

Taps designed for water flow cannot be used for honey, which is very viscous and flows only slowly. Honey gates for fitting to extractors and tanks should be hygienic and easily cleaned; they should cut off the flow of honey instantly, with no drip, as soon as they are closed, and they must incorporate a safety device (often a screw) to prevent accidental opening from the closed position.

Honey gates are usually made of brass, stainless steel or plastic, and the diameter of the opening can range from 32mm to 76mm. Most large beekeeping suppliers sell them.

Available from:
GENERAL SUPPLIERS



EXTRACTOR FOR COMBS FROM TOP-BAR HIVES

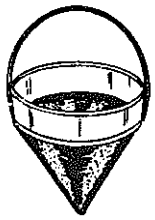
These combs do not have the support of a full frame, or the strength of combs built on wired foundation. They cannot withstand the force of a normal extractor, but a small tangential extractor can be adapted by providing wire-mesh baskets in place of the usual grids. Unframed combs (or pieces of comb) are carefully placed in the baskets. The extractor must be spun twice, once with each side of the basket innermost.

A larger extractor (illustrated), for combs from a top-bar hive, contains 6 pairs of baskets mounted horizontally, the whole taking 12 combs. Baskets are removed from the top, pair by pair, and combs inserted before they are replaced in the extractor. This extractor is wired for electric operation, but could be adapted for use without electricity. It is produced by:

ETS THOMAS FILS SA
65 rue Abbé Georges Thomas
BP No. 2, 45450 Fay-aux-Loges
FRANCE

HONEY STRAINERS

Commercially sold honey strainers are designed to take honey as it leaves the extractor, containing no more than small bits of wax from cappings. Modern quality requirements demand that final straining is through a very fine mesh, and this process is speeded up if all but the smallest particles have been removed first, by one or more strainers of larger mesh. As with other operations on honey, straining is faster if the honey is warm; honey flows roughly twice as fast for every rise of 10°C. Light and dark combs should be strained separately, into different containers, since the flavour of the darker honey may not be as fine.

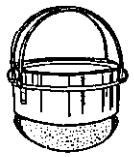


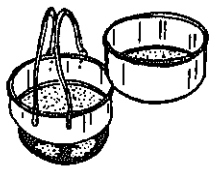
SIMPLE HONEY STRAINER

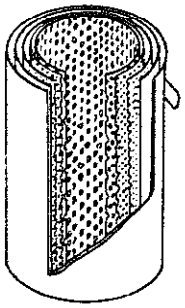
The least expensive type of honey strainer is suspended from the honey gate of the extractor. On the left the honey is strained through a single cone of finely perforated metal. On the right an upper coarse wire mesh retains the larger particles, speeding up the flow through the lower fine wire cloth; below right these two strainers are shown separately. The strainers shown are sold by:

E.H. THORNE (BEEHIVES) LTD
Wragby, Lincoln
LN3 5LA
U.K.

The above strainers are practical only for small amounts of honey. Somewhat similar strainers can be purchased with (or to fit at the top of) a polythene tank holding 70kg (see below).







Dimensions in cm:
External diameter: 43
Diameters of screens: 18, 23, 28, 33
Height: 76
Outlet diameter: 7.5

OAC HONEY STRAINER

This well tried strainer for larger-scale operations was developed at Ontario Agricultural College (now the University of Guelph), in Canada. It consists of a cylindrical tank with a series of four cylindrical coaxial screens, one inside the other. From the centre, they have approx. 5, 12, 20, 30 mesh/cm. Honey enters the tank at the top, inside the innermost screen, with the largest mesh. It passes through the screens and is drawn off, also near the top. Each screen, and the tank, has a drainage gate at the bottom. This strainer has a large straining area for each mesh, and will handle 2 tonnes of honey a day at 30°C. In temperate climates, it can be operated successfully without heating the honey. The OAC strainer is sold by:

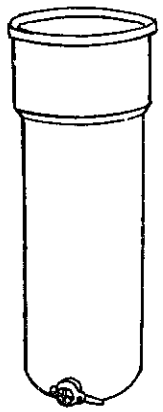
F.W. JONES & SON LTD
44 Dutch Street
Bedford, Quebec J0J 1A0
CANADA

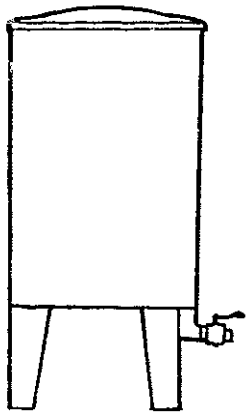
HONEY STRAINER AND SETTLING TANK

For small-scale operation, many beekeepers use a tank with two or more screens at the top, the upper one having the larger mesh. A honey gate (see above) is fitted near the bottom for removing honey, and the tank can be tilted for final draining. When honey stands in the tank, any remaining particles of beeswax rise to the top (hence the term 'settling' tank.)

Many general suppliers sell these tanks. The tank shown is made of polythene and holds 70kg of honey; it is sold by:

E.H. THORNE (BEEHIVES) LTD
Wragby, Lincoln
LN3 5LA
U.K.





HONEY STORAGE TANKS

Containers in which honey is stored should be inert (giving no interaction between the vessel and the honey) and easy to clean. Honey is a food product, and it has a delicate flavour, and on both counts must not be stored in metal drums that cannot be cleaned, or that are scratched or damaged. Plastic and stainless steel are ideal materials for smaller and larger honey tanks, respectively. The containers must also be tightly closed and moisture resistant, or the honey in them will absorb moisture and may then ferment. The tank shown is made of stainless steel and holds 2 tonnes. It is provided with a stand since it is too heavy to be tilted for emptying. The base slopes down to the gate fitted at the lowest point.

A specialist manufacturer of these tanks is:

MAXANT INDUSTRIES INC.
P.O. Box 454, Ayer, MA 01432
U.S.A.

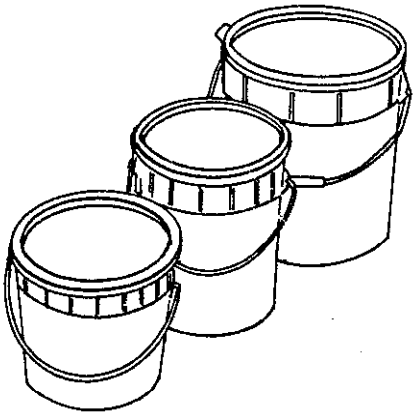
HONEY CONTAINERS FOR MARKETING

As with honey storage tanks, the material must be inert and easily cleaned. Airtightness is essential, especially in humid climates, or the honey will absorb moisture from the air and will then be liable to ferment. Only plastic containers are described here; there is no chance of contamination as there is with metals (other than stainless steel). Glass jars are heavy, liable to break, and cannot be stacked one inside the other, so they are expensive to transport.

LARGE POLYTHENE PAILS (2 to 30kg)

These usually have a reinforced rim, a press-on lid fitting tightly, and a wire handle. Those illustrated right are sold by:

PRO-WESTERN PLASTICS LIMITED
150 Riel Drive, P.O. Box 261
St. Albert, Alberta, T8N 1N3
CANADA

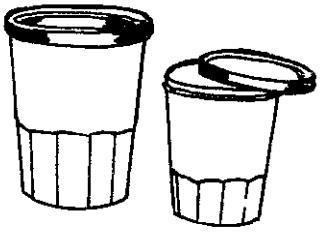


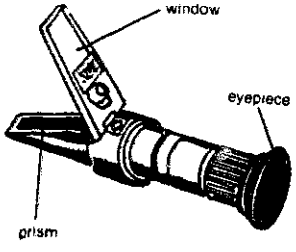
SMALL PLASTIC POTS (0.5 to 2kg)

These have tightly fitting (re-usable) press-on lids. They may be tall or squat, opaque or transparent. For liquid honey, tall transparent pots are preferable, to minimize the chance of leakage and to show the honey off to advantage. For granulated (crystallized) honey, opaque pots are often used, because surface irregularities in crystal formation are then not visible.

Suppliers of tall pots (illustrated right) include:
SAF, s.n.c.
Via Liguria 17, 36015 Schio (VI)
ITALY

Suppliers of squat opaque pots:
LILY CUPS DIVISION
P.O. Box 2195, Auckland
NEW ZEALAND





HONEY REFRACTOMETER

A refractometer measures the refractive index of a substance, and one calibrated specifically for honey is very useful because the refractive index depends on the total percentage of sugars in the honey. The refractometer is usually calibrated directly in percentage of water (moisture). The upper limit in the proposed FAO/WHO Codex is 21 per cent, but most honey producers and traders would regard 18 per cent as a proper limit. Instructions are sent out with each refractometer, and they include a table of temperature corrections, since the refractive index is substantially affected by temperature. Some refractometers are calibrated in degrees Brix (a form of measurement of the sugar content in a substance).

In operation, a few drops of honey are placed on the prism (left of drawing), and the hinged window closed down on them, spreading them into a very thin 'sandwich'. On viewing through the eyepiece (right of drawing) against a good light, the scale will be seen, with an indicating line showing the reading. Since so little honey is used, it is most important that it is representative of the sample, and that the glass surfaces are completely dry. Some refractometers incorporate a thermometer. The following firms supply honey refractometers:

BEEMAID
625 Roseberry Street
Winnipeg, Manitoba R3H OT4
CANADA

A. ECROYD AND SON LTD
P.O. Box 5056
25 Sawyers Arms Road
Papanui, Christchurch S5.
NEW ZEALAND

GIFU YOHO CO LTD
Kano-Sakurada-cho 1
Gifu-Shi, Gifu 500-91
JAPAN

STEFAN PUFF GmbH
Neuholdaugasse, 6011 Graz
AUSTRIA

SOPELEM
102 rue Chepital
92306 Levellois, Perret
FRANCE

PFUND COLOR GRADER

This instrument is used in the world honey market for measuring the 'colour' (darkness) of honey; it compares the opacity of a honey sample with that of a standard 'amber' liquid. The honey sample is placed in a wedge-shaped trough which is moved past a narrow slit in the housing until a colour match is obtained, i.e. the colour density of the honey matches that of the amber wedge. The reading on a millimetre scale is then the 'Pfund scale' reading for the honey, which corresponds to one of the following standardized colour names in the USA (in Canada and Australia the definitions are slightly different): up to 8mm water white; up to 16mm extra white; up to 34mm white; up to 50mm extra light amber; up to 85mm light amber; up to 114mm amber; over 114mm dark amber. Available from:

XPORT
Port Authority Trading Company
1 World Trade Center, 55NE
New York, NY 10048, U.S.A.

POLLEN TRAP

Honey and beeswax are the most commonly harvested hive products. Pollen, compared with honey, has a high protein, vitamin and mineral content, and in some countries is harvested and processed for sale. Harvesting is done by using a pollen trap, a device incorporating a hive entrance in which incoming bees must pass through two parallel grids of suitable mesh, with the result that pollen loads in the bees' hind legs are knocked off and fall into a collecting tray below. It would be dangerous to prevent any pollen entering the hive for more than a day or two, because brood rearing would cease, but use of traps is organised to prevent this.

Most pollen traps on sale are fitted at the bottom of a hive (and must have the same cross-section), either immediately above the normal floorboard or instead of it. Other designs are used at the front of the hive or at the top, with an upper hive entrance. Commercially available pollen traps do not necessarily fulfil all the conditions for successful use under all conditions without harm to the colony. International Bee Research Association Publication M86, *Pollen and its harvesting*, explains the problems and gives recommended designs not on sale.

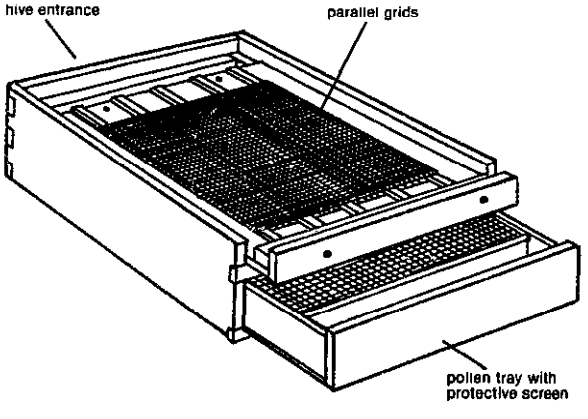
Pollen is a highly nutritious food, and therefore a good medium for the growth of micro-organisms. For this reason pollen traders in technologically advanced countries may be unwilling to import pollen from untried sources.

The pollen trap shown is sold by:

HONEYBEE PRODUCTS
Amery, WI 54001
U.S.A.

Another supplier is:

KOREA BEEKEEPING APIARY
1155-1, Soong In-Dong
Chongro-Ku, Seoul
KOREA



BEESWAX PROCESSING EQUIPMENT

Beeswax is a valuable hive product, and should bring the beekeeper an added income. Unlike honey, it needs no container, and no special care in even long storage. In spite of this it is all too often thrown away. Beeswax has traditionally been exported from tropical countries. There may be little or no local use for it, and a beekeepers' co-operative or similar body may be needed to organize its sale to beeswax traders. When beeswax cappings, combs, etc. have been washed free from honey, or have been cleaned by bees, the beeswax is melted to let everything that is not pure beeswax separate out by sinking to the bottom. It is essential that light combs should be treated separately from dark ones, because light wax will fetch the highest price.

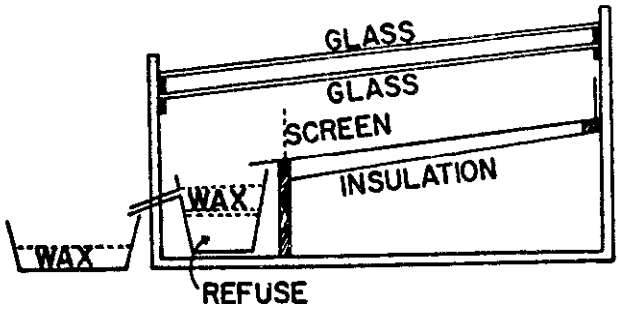
Beeswax *must* be heated in a safe way, or there is danger of a fire. The first apparatus described is ideal in this way, costs nothing to operate, and can produce very high quality wax.

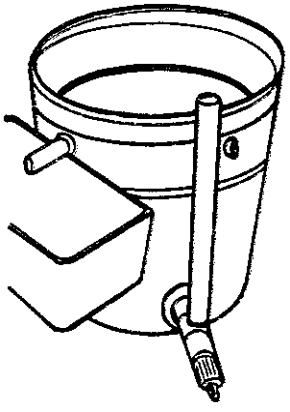
In some areas, traders may be suspicious that blocks of wax offered for sale have stones in them, to add to their weight; any such stones would not be visible. In such areas, it is best to make rather thin blocks, which could not hide stones.

SOLAR WAX EXTRACTOR

The wax pieces are put on a metal base, closed in by four sides and a lid consisting of two sheets of glass 5mm apart; the whole is tilted at a suitable angle to catch the sun's rays. Below the base is an insulating layer to reflect the heat back. Heat is trapped inside the box, and melted wax runs down the sloping base (leaving most of the dross behind), and into a container within the box. A second external container can be incorporated, as in the drawing.

Available from:
GENERAL SUPPLIERS

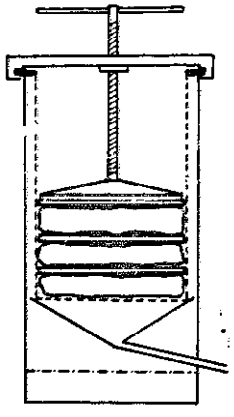




HOT-WATER BEESWAX PROCESSOR

In principle this is a vessel in which water and unprocessed beeswax can be heated together and (a) the beeswax floats on the top and is drained off, leaving behind the dross and the dirty water; (b) more water can be added at the bottom, to raise the beeswax layer to the correct level for draining. The drawing shows a simple type produced by:

HONEY & BEE DIVISION, SHOTS INC.
4418 Josephine Lane
Robbinsdale, MN 55422
U.S.A.

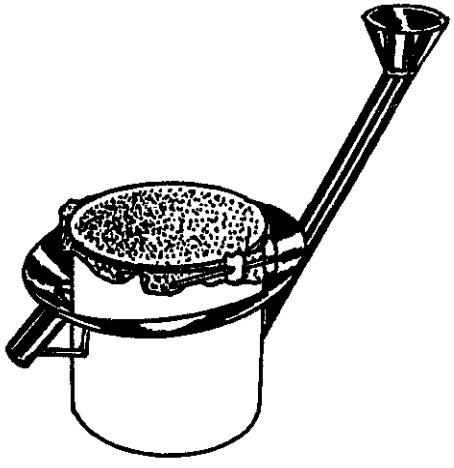


STEAM BEESWAX PRESS

The type illustrated consists of a steamer fitted with a screw plunger. Steam generated from water at the bottom of the container reaches the combs wrapped in canvas bags through the perforated basket into which they are placed; the bags are separated by wooden boards. The cross-arm is locked in position so that the combs are under pressure, and the melted wax runs through the basket and out of the tube. When the wax flow ceases, further pressure is applied. It is necessary to turn the screw back and shake up the bags before renewing the pressure, to extract all the wax, which should be done in 2 or 3 operations, leaving only 1 to 3 per cent dross behind.

Several slightly different models are supplied, one fairly similar to the drawing by:

STEFAN PUFF GmbH
Neuholdaugasse, 8011 Graz
AUSTRIA



MOUNTAIN GREY BEESWAX EXTRACTOR AND CLARIFIER

This appliance gives much cleaner wax and is very satisfactory in operation. It can be used for clean combs or dirty wax, but will not extract all the wax from cocoons or pollen of brood combs. It melts the wax in water and strains it through a coarse cloth covering the top of the container.

The two-gallon steel container has a long funnel or filler tube leading from the bottom, the top of the funnel being well above the top of the container itself. Round the outside of the container is a collecting channel for the wax, that slopes to a spout. A straining cloth is fitted over the top of the container and is held in position by means of a wire clip. The container is one-third filled with clean water, either rain water or tap water to which a little vinegar has been added (rather less than 1 per cent). The water is heated on a stove and the wax, previously soaked in water, is put into the container and the whole stirred until the wax is melted. Wax can be added until the surface comes to within 5-6cm from the top. When all the wax is completely melted, the appliance is taken off the stove and the straining cloth secured in position with the wire clip.

The wax floats to the top of the water, and more water is added through the funnel, which exerts enough pressure to force the wax through the cloth and into the collecting channel.

This extractor is obtainable from some British suppliers including:

E.H. THORNE (BEEHIVES) LTD.
Beehive Works, Wragby
Lincoln LN3 5LA
U.K.

PROPOLIS COLLECTOR

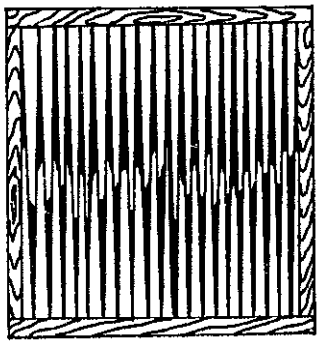
Bees gather a sticky resin known as propolis, from certain trees that produce it. They use it to close up gaps in their hive, or to reduce the hive entrance.

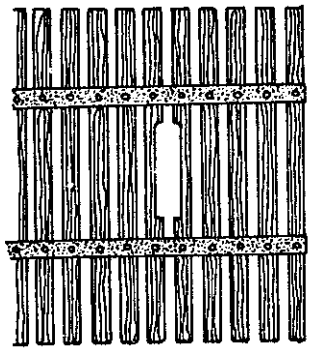
Propolis contains a number of antibiotic substances, derived from the plants on which the bees find it. Its use in the pharmaceutical industries of some countries is accepted. The demand for propolis, and therefore the price it fetches, vary greatly from year to year, so enquiries should be made before embarking on a programme to produce it. It is also wise to deal with an established trader: propolis is rather new as a commercial product, and therefore attracts new traders, some of whom are unable to continue. On the other hand (unlike pollen) it is relatively stable in storage. If the demand for it increases, it could provide a useful additional source of income.

The principles of harvesting are simple. A flat sheet with slits (of a width that bees will close with propolis) is inserted at the top or at the side of the hive (where the bees will regard it as the outside wall of their nest). When the slits are well closed up with propolis the sheet is removed and placed in a deep freeze; the propolis is subsequently released from the sheet by shattering.

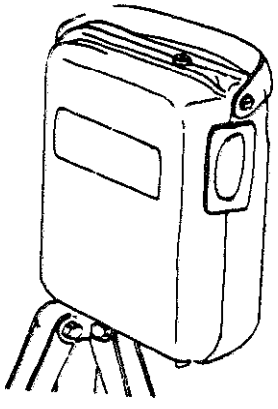
The only firm known to market a propolis collector for placing above the top hive super is:

HUNGARONEKTÁR
Budapest 1054
Garibaldi u.2
HUNGARY





13. MISCELLANEOUS



COWLEY AUTOMATIC LEVEL

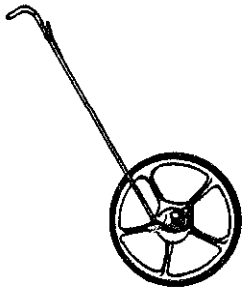
The Cowley level is a low-cost instrument suitable for all levelling purposes. It combines simplicity with speed and accuracy. It is accurate to 0.6 cm in 30 metres and can be fitted with a slope attachment for use where standard slopes are being set out. (Illustrated left.)

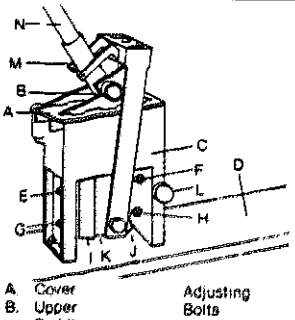
DRIVALL LTD
Churchbridge Works
Cannock
Staffordshire SW11 3JP
U.K.

LAND MEASUREMENT WHEEL

This simple device enables one man to measure distances as fast as he can walk. A counter automatically records revolutions of the wheel or distance travelled. Available in wheel sizes with 1.52 m, 3.05 m, or 1 metre circumference (Illustrated right.)

GANDY COMPANY
528 Gandrud Road
Owatonna
Minnesota 55060
U.S.A.





A. Cover
B. Upper Saddle
C. Mold Box
D. Baseboard
E. & F. Upper Adjusting Bolts
G. & H. Lower Adjusting Bolts
I. & J. Guide Plates
K. Piston
L. Lower Rollers
M. Lever Latch
N. Handle

CINVA-RAM BLOCK PRESS

The CINVA-Ram Block Press is a simple, low-cost portable machine for making building blocks and tiles from common soil. The press, made entirely of steel, has a mould box in which a hand-operated piston compresses a slightly moistened mixture of soil and cement or lime. Bearing strength (Fully cured blocks): 14-35 kg/cm$_2$.

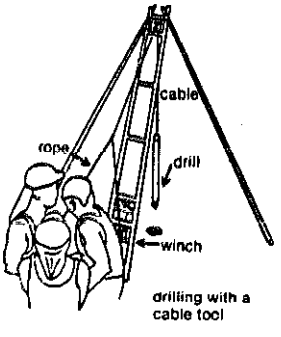
Size of block: 9 cm × 14 cm × 29 cm.

Average number of blocks per 100 lbs of cement: 150.

Among many manufacturers it is available from:

BELLOW'S VALVAIR INTERNATIONAL
200 W. Exchange St.
Akron, Ohio 44309
U.S.A.

METALISEC LTDA.
Apartado Aereo 233 NAL 157
Bucaramanga
COLOMBIA



drilling with a cable tool

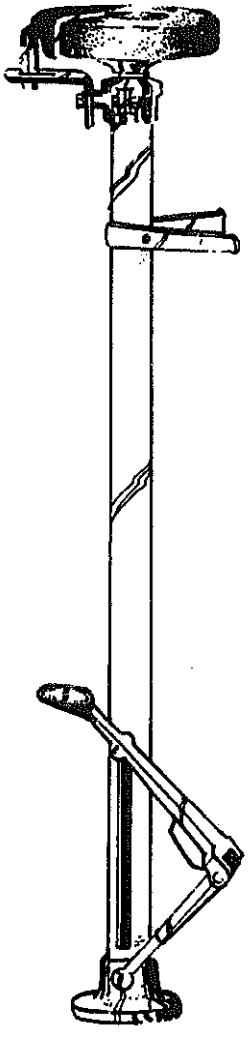
PERCUSSION DRILLING RIG

This can be used for constructing a small diameter well. The technique, known as the cable tool method, consists of repeatedly raising and dropping a chisel-edged bit to break loose material from the bottom of the hole. A little water is kept in the hole so that the material mixes to form a slurry. Periodically the percussion bit is removed and a bailer lowered to withdraw the slurry. When the hole has been emptied, drilling is resumed; drilling and bailing are then alternated. This method is versatile, allowing all types of material to be penetrated, but in very hard stone progress is slow.

VAN REEKUM MATERIALS BV
P.O. Box 98, Kanaal Noord 115
7300 AB Apeldoorn ,NETHERLANDS

Other manufacturers are:

V & W ENGINEERING & INSTALLATIONS PVT LTD
P.O. Box 131, Harare, ZIMBABWE



ALLBALL GRINDER

This treadle-operated grinder for sharpening knives has a gearless, helical ball-bearing drive which produces high wheel speed with minimum effort. Its main working parts are case-hardened and ground. It is dust proof, compact and portable. It has a large wheel surface to give maximum service, and no dust is thrown in operator's face. A high-grade six-inch carborundum wheel supplied as standard.

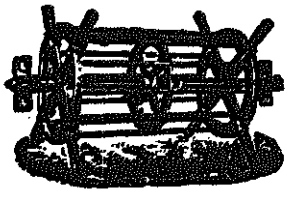
HEYDEN MACHINERY LTD
Treleigh Terrace
Redruth
Cornwall TR15 1DP
U.K.

WATERING CAN

The universally available watering can provides a means for small-scale gardeners and farmers to water their crops efficiently, whatever the land form.

E. TINSLEY & CO LTD
P.O.B. 35, Raddalhill Road
Cradley Heath, Warley
W. Midlands B64 5JF, U.K.

KUMAON NURSERY
Ramnagar — 244715, Nainital, U.P.
INDIA



WINDLASS

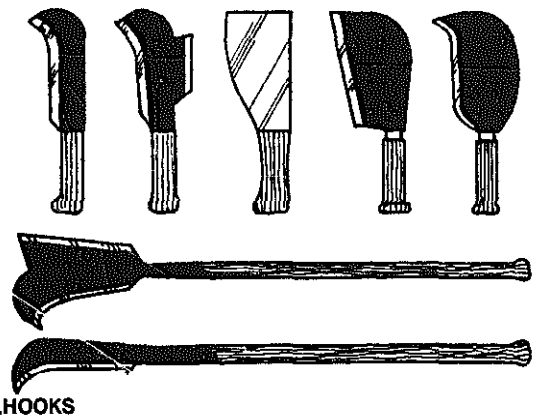
It is strong and durable and easy for drawing water from wells. Useful for domestic and public wells. Supplied with one MS axle and 2 bearings. Available in two sizes: 85 cm and 100 cm.

DANDEKAR BROTHERS
(Engineers and Founders)
Sangli-Shivaji Nagar, 416 416
Maharashtra
INDIA

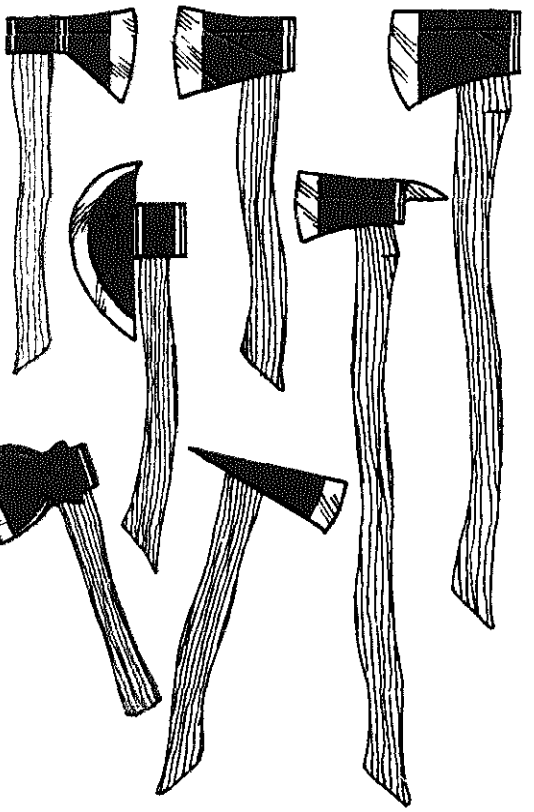
LAND CLEARANCE

Careless clearance of trees could cause permanent economic damage through irreversible degradation of the soil. Lush tropical vegetation can grow without nutrient deficiency symptoms in soils of very low native fertility. When this is cleared, significant changes in physical soil properties take place. Soil and air temperatures increase because more solar radiation reaches the soil surface. Soil moisture regimes are also altered, with less moisture removal from the subsoil than when forest roots are active. Soil structure deterioration which leads to runoffs and erosion losses occurs in poorly aggregated topsoils subjected to inappropriate management practices.

When it has been decided that clearance of the existing vegetation is necessary, careful planning will minimize the negative effects. A detailed land-use plan is required which shows the existing trees, topography, soils and rainfall pattern, the order, time-scale and extent of clearance; and the planned tree and crop cover throughout the year. The future production plans will show the range of products to be extracted and the production methods to be used which will determine the kind of clearance that is required — whether, for example, tree stumps need to be removed or large areas need clearance of debris for mechanical cultivation. Detailed local knowledge of existing tree clearing practices is essential. It may be that these are adequate for the task, but *if not, information on the availability of* local manpower, equipment and servicing is required. If these too are inadequate further investigation of sources of equipment and spares within the country and from overseas is necessary.

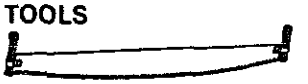


BILLHOOKS



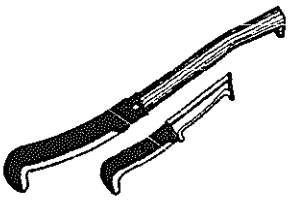
AXES

HAND CLEARING TOOLS



TWO-MAN SAW

Machetes, slashers and bill hooks are useful for cutting down small bushes with stems up to about 8 cm diameter. Larger trees can be cut with a felling axe. A two-man saw is faster than an axe for *cutting trees of more than about 50 cm* diameter. The max. size which can be sawn depends on length of saw. Wedges are often used to prevent the saw jamming. The equipment can be maintained by user or a village blacksmith. Saw sharpening is a skilled job, but can be done by the user after training. The equipment could be made by a blacksmith, except the saw, which would be made in a small factory. *Operator skill is needed to prevent* damage from falling trees.

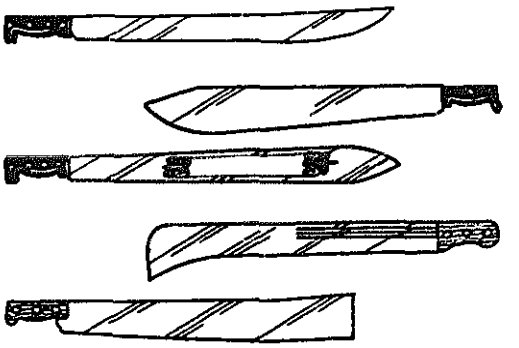


BRUSH HOOKS

Technical Specifications:

	No.19051	No.16032
Weight (kg)	1.3	0.7
Length (mm)	840	450
Blade length (mm)	280	240
Handle	Birch	Plastic

FISKARS
Mannerheimintie 14 A
P.O. Box 235
SF — 00101 Helsinki
FINLAND



MACHETES

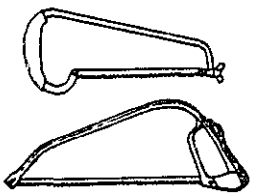
CHAINSAWS

The following is a brief selection of manufacturers of chainsaws:

JONSEREDS, Jonsered Motor AB
S-433 81 Partille, SWEDEN

ALPINA
31015 Conegliano
Treviso
ITALY

PIONEER CHAINSAW CORPORATION INC
775 Neal Drive, Peterborough
Ontario, CANADA K9J6X7

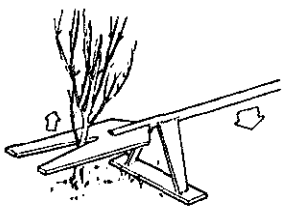


BOW SAWS

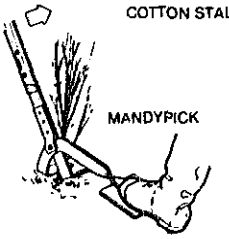
From many manufacturers of bow saws, two are listed below.

OUTILS FAM
44 Rue Flammarion
52800 Nogent-en-Bassigny
FRANCE

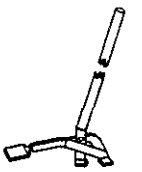
POLAR WERKE GmbH
Postfach 140460
5630 Remscheid 1
W. GERMANY



COTTON STALK PULLER



MANDYPICK



HAND UPROOTING TOOLS

These tools can be used to uproot small bushes with stems less than about 2 cm in diameter provided that the ground is not very hard. They are more efficient for uprooting bushes than spades or mattocks and little training in their use is necessary.

PROJECT EQUIPMENT LTD
Industrial Estate, Rednal Airfield
West Felton
Oswestry
Salop SY11 4HS, U.K.

CLEARING SAWS

These machines have a rotary saw blade driven by a small petrol engine mounted on the body of the saw, or as a knapsack-carried motor with a flexible drive to the saw. They can cut down trees with stems up to 20 cm in diameter. Below are listed several manufacturers of different types of clearing saw:

ALPINA
31015 Conegliano
Treviso
ITALY

GRANJA S.A.
109 Route de Toulouse
31270 Cugnaux
FRANCE

OUTDOOR POWER EQUIPMENT LTD
P.O. Box 3111
301-303 Queen Street
Richmond
Nelson
NEW ZEALAND

COSMO INCORPORATED
Towa Bldg 4th Floor
10,4-Chome, Awaji-Machi
Higashi-Ku, Osaka
JAPAN

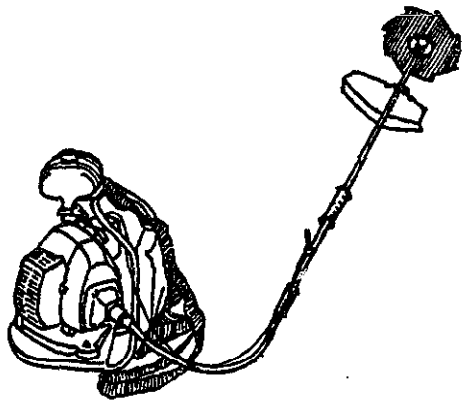
JONSEREDS
Jonsered Motor AB
S-433 81 Partille
SWEDEN

KUBOTA
2-47 Shikitsuhigashi 1-Chome
Naniwa-ku
Osaka 556-91
JAPAN

KOREA TRADE PROMOTION CORPORATION
C.P.O. Box 1621
Seoul
KOREA

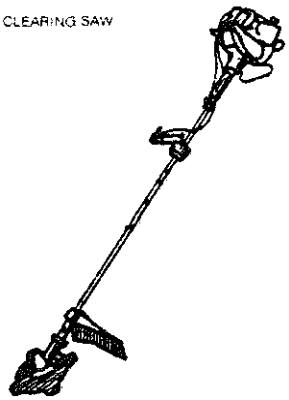
DANARM LTD
Stafford Mill Estate
London Road
Stroud
Glos. GL5 2BP
U.K.

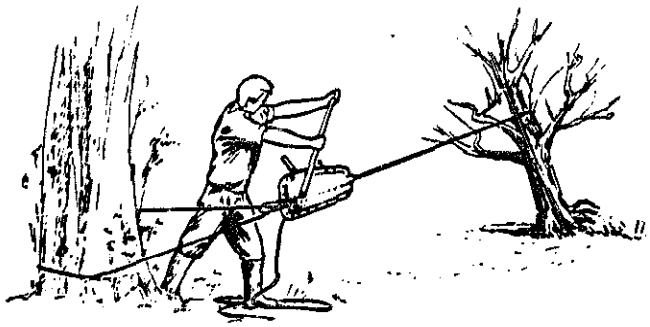
OPERATOR WEARING PROTECTIVE HEAD GEAR



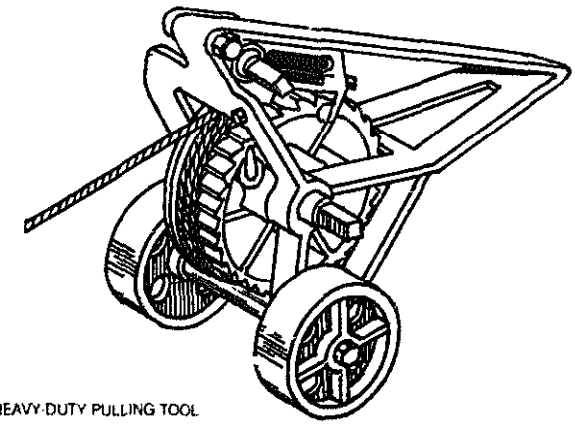
CLEARING SAW WITH KNAPSACK MOUNTED MOTOR

CLEARING SAW





LIGHTWEIGHT PULLING TOOL



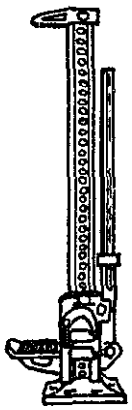
HEAVY-DUTY PULLING TOOL

MONKEY WINCH

(Illustrated right.)
- Has proved itself efficient in many parts of the world.
- Will work on any class of timber, and in addition to the purpose for which it was originally designed, it is capable of all classes of hauling or lifting.
- The standard set of ropes will pull trees up to 30 m from the anchorage at full power, and 40 m when working at double speed (and half power) on light work.
- From one anchorage you can reach all trees and stumps on about 1 hectare.
- The Monkey Winch has passed a British Ministry of Agriculture test, extracting 27 small stumps in 2½ hours.
- It is simple, reliable and effective.

Monkey winch and handle: Drum rope: 15.25 m × 18 mm. Anchor rope: 4.57 m × 22 mm. Pull rope: 24.4 m × 22 mm.

TREWHELLA BROS (UK) LTD
Rolfe Street, Smethwick
Warley, West Midlands B66 2BA, U.K.



UNIJAK

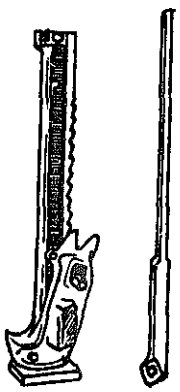
- Manufactured from high-grade alloy castings.
- Steel pillar which may be reversed for extra long wear.
- 10 cms pick-up height.
- 120 cms lifting height.
- 95 cms continuous lift.
- 3,000 kilos capacity.
- Weight 13.2 kilos.
- Area of base plate approximately 200 sq. cms. (Illustrated above.)

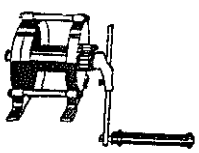
CE MONKEY JACK

The super-power monkey jack, illustrated below, for heavy timber work and lifting of all kinds. Supplied with 2 spears, a short one for general work and small trees, and a long one to allow great force to be exerted on taller trees.
- Total lift 620 mm.
- Bottom claw height 130 mm.
- Top claw height 400 mm.
- Minimum spear height 1,190 mm short, 2,040 mm long.
- Weight 88 kilos.

Both models available from:

TREWHELLA BROS. (UK) LTD
Rolfe Street, Smethwick
Warley, W. Midlands B66 2BA, U.K.





DRUM WINCH

For extremely heavy-duty operation, with very strong body and crank (crank is adjustable).

Rope: Diameter 12 mm; up to 30 m.
Capacity with check lever: 5 tonnes.
Capacity without check lever: 1.5 tonnes.
Net weight, approx: 45 kg.

TECHNICAL ASSISTANCE (INTERNATIONAL)
P.O. Box 1224
Vosskuhlenweg 2
2072 Bargteheide
W. GERMANY

MANUFACTURERS OF AXES

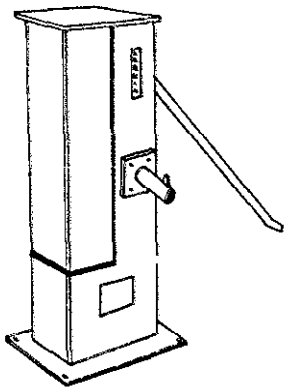
Manufacturer	Country							
AÇOTUPY	Brazil	●	●			●		
AGRIMAL	Malawi							●
BULAWAYO STEEL	Zimbabwe	●	●					
CALDWELLS	U.K.	●					●	
CEAF	Italy	●	●	●				
LEON CLÉMENT	France	●	●	●	●	●		
BORAL CYCLONE	Australia	●		●			●	
EDELMIRO VAZQUEZ	Spain	●	●			●		
EICHER	India		●					
ELKEM SPIGERVERKET	Norway	●						
FERFOR	Portugal	●	●	●		●	●	
FISKARS	Finland	●	●					
FREDERICH	France	●	●					
GILPIN	U.K.	●		●		●	●	
HERRAGRO	Columbia	●	●					
IMACASA	El Salvador	●	●					
JENKS & CATTELL	U.K.						●	
KOREA TRADE	Korea	●		●				
KUMAON	India	●	●				●	
LANG FERRY	France	●	●				●	
MORIN	France		●		●			
PARKES	U.K.		●					
PETROLEUM SERVICES	Malawi							●
RAJAN	India		●	●				
REVEX	France	●	●					
SANDVIK	Sweden	●						
SPALDING	U.K.	●						
SPEAR & JACKSON	U.K.		●	●				
SYNDICATE DE L'OUTILLAGE	France	●	●					
TEMPER TOOLS	Zimbabwe	●	●					
TROJAN	Australia			●				
TROPIC	Cameroon	●	●					
WÜRTT.	W. Germany		●					
ZANA ZA KILIMO	Tanzania		●					

MANUFACTURERS OF BILL HOOKS

Manufacturer	Country							
BULLDOG	U.K.	●	●					
CALDWELLS	U.K.	●					●	
CEAF	Italy	●	●	●		●		
LÉON CLÉMENT	France	●				●		
EDELMIRO VAZQUEZ	Spain			●				
IMACASA	El Salvador			●		●		
KUMAON	India	●	●	●				
LANG FERRY	France		●		●	●		
PARKES	U.K.	●						
RAJAN	India			●				
SEYMOUR	U.S.A.						●	
SPALDING	U.S.A.						●	
SPEAR & JACKSON	U.K.	●	●	●			●	●
SYNDICAT DE L'OUTILLAGE	France	●						
TEMPER TOOLS	Zimbabwe			●				
TROJAN	Australia							●
WÜRTT.	W.Germany	●						
ZANA ZA KILIMO	Tanzania	●	●					

MANUFACTURERS OF MACHETES

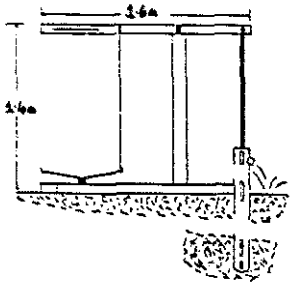
Manufacturer	Country					
AÇOTUPY	Brazil		●			
CALDWELLS	U.K.	●	●	●	●	●
EICHER	India	●	●	●		
FERFOR	Portugal	●	●	●	●	●
GHERARDI	Argentina		●			
HERRAMIENTOS	Ecuador		●	●		
IDEAL CASEMENTS	Kenya		●			
IMACASA	El Salvador	●	●	●	●	●
KENYA INDUSTRIES	Kenya		●	●		
KOREA TRADE	Korea	●			●	
RALPH MARTINDALE	U.K.	●	●	●		
SYNDICAT DE L'OUTILLAGE	France		●			
TROJAN	Australia				●	
TROPIC	Cameroon		●			●
WOLF & BANGERT	W. Germany	●	●	●	●	●



KARDIA HANDPUMP

This new KARDIA handpump replaces the former model. It is constructed from stainless steel and PVC parts. It operates in bore holes with a minimum diameter of 100 mm. The cylinder, piston and ratio of handle transmission operate with a lift of up to 40 m. Stroke length is 150 mm. The yield varies according to speed of pumping from 810 litres/h for 30 strokes/min to 1620 litres/h for 60 strokes/min.

PREUSSAG AG
Postfach 6009
3150 Peine
W. GERMANY



FOOT-OPERATED PUMP

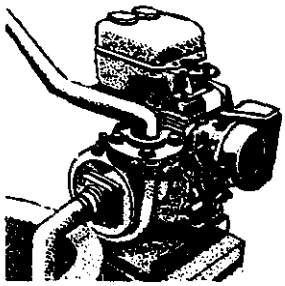
This easily maintained foot-operated pump is not affected by sand or dirt in the water supply.

Pumpframe dimensions: Height 1.4 m (approx.); length 1.6 m (approx).

Material: Metal frame with PVC bearings.

Output: 1.6-2.0 m^3/h.
Maximum lift: Approx 40.0 m.
Available from:

STANDARD LANDMASCHINEN GmbH
Postfach 1160
3118 Bad Bevensen
W. GERMANY



AGRICULTURAL PUMPS

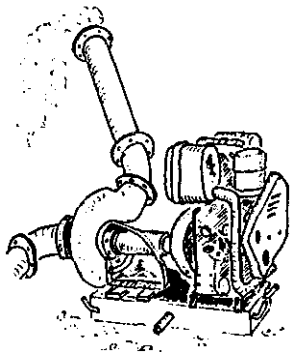
The 200/JR (Junior) is a 5 cm pump designed to give large outputs at low delivery heads, and uses a smaller engine that the 200/SR (Senior) which is also a 5 cm pump but having an even larger output and achieving higher delivery heads than the Junior pump. The 300/JR is a 2.5 cm pump giving a high output at medium delivery heads. The maximum suction lift of all 3 types is 7.5 m.

The pump body and casing are constructed of close grained cast iron.

Impellers of either the closed or open type and also cast iron impellers can be supplied as specified.

These pumps are fitted with "Sinha" (Robin) single cylinder, air cooled, 4 stroke, petrol/kerosene engines. The 200/JR pumps are fitted with 130 cc TS 18 engines. Type 300/JR are fitted with "Robin" EY 33 2 DK engine.

JINASENA LTD
P.O. Box 196
Colombo
SRI LANKA



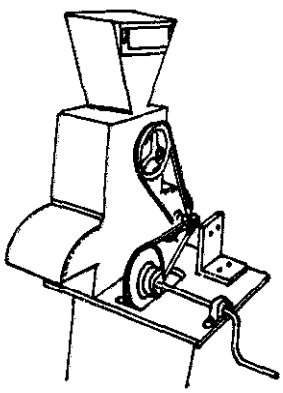
PUMPSETS & POWER UNITS

Henkelhausen produce a range of stationary and mobile pumpsets (of which one is illustrated above) and power units. The technical supply specification is as follows:

Starter motor 12 V; generator 12 V; batteries with box, for use in tropical areas; switch board with instruments for oil, temperature, tachometer; automatic shut-down; lube oil filter; fuel filter with water trap; flanged on outer bearing with free shaftend; v-belt monitor stop switch contact; dry type air cleaner with safety cartridge; mounted silencer with exhaust pipe; v-belt guard; base-frame.

The specification of the H4017 Power Unit is as follows:
engine: F2L 912.
output (kw): 17.
speed (rpm): 1 800.
length (mm): 1 300.
width (mm): 850.
height (mm): 1 100.
weight (mm): 355.

HENKELHAUSEN
Hafenstraße 51
4150 Krefeld 12 (Linn)
W. GERMANY



DMC-1 HAND SHELLER

This is used for shelling seed on a small scale. It can be turned by hand or with bicycle sprockets and pedals. It mounts on a base that has a 10cm square centre hole. Peanuts are poured into the hopper and fall into the shelling grate. Hulls are blown out of the spout. Seed peanuts drop through the bottom of the unit into a bag hung on the underside of the unit. To remove the hulls left in the shelling grate, lift the clean-out door and turn the crank. The shelling grates can be exposed for changing by removing two screws and dropping the upper section at the hinges. There are only four bearings to replace.

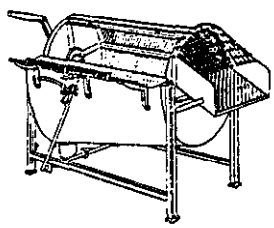
The unit weighs 23 kg measures 60 cm square and has a shelling capacity of 25-50 kg. It is manufactured by D.M. Carter Mfg. Co. and is available through:

OPICO
P.O. Box 649
Mobile, AL 36601
U.S.A.

WEASEL

The Weasel is a tool similar to the Spintiller on page 38 which scarifies the surface of the soil. It has rotating pairs of wheels which run crosswise against each other.

BRAUCKE GmbH
Postfach 201005
4800 Bielefeld 1
W. GERMANY



VEGETABLE WASHER

This machine is available in two models: P1 is hand operated; P2 can be adapted for motor drive. Output: 100-200 kg/h. Weight: 130 kg.

MARPEX
1 rue Thurot
4000 Nantes
FRANCE

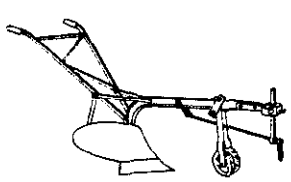
IMPACT PULVERIZER

Cecoco make a wide range of models of similar construction ranging in power requirement from 0.5 to 50 hp and with mesh sizes 2.0 to 0.1 mm. They are used to pulverize any materials for food supply, fertilizer, ores, chemicals etc. The feed material, kept in the hopper, is regulated by a damper and enters the grinding chamber via a shaker and magnetic box. The feed material is pulverized by shock and the tearing action between rotor and stator revolving at high speed. Powder fine enough will pass through the screen into a chute for collection. A bag filter is used to clean the discharged air. The pulverizer is usually mounted on a stand with the motor. Specifications for some of the 8 models available are:

Model	Power required (hp)	Rotor diameter (mm)	Rotor speed (rpm)
No.0	0.5-1	152	7000
No.1	2-3	270	5000
No.2	3-5	299	4500
No.3	5-7.5	472	3200
No.4	15-20	533	2800

Model	Weight (kg)	Output (kg/h) Rice	Output (kg/h) Maize
No.0	35	20	20
No.1	98	40	55
No.2	210	80	150
No.3	600	160	300
No.4	630	500	900

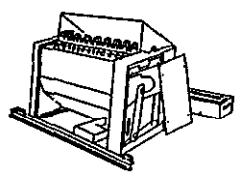
CECOCO
P.O. Box 8
Ibaraki City, Osaka 567
JAPAN



ANIMAL DRAWN PLOUGH

This manufacturer produces a plough similar to the Victory plough.

GGADP IMPLEMENT FACTORY
P.O. Box 171
Tamale
GHANA



PEDAL-POWERED THRESHER

Unlike other pedal-powered threshers, this model is equipped with a blower for winnowing the threshed grain. The machine is light and portable.

BORMEO G. MODANZA
1285 Maceda St
Sampaloc
Manila
PHILIPPINES

SOURCES OF FURTHER INFORMATION

This section contains information which is intended to supplement the material in the main text.

1. Institutions and Organizations This lists, alphabetically under country, some of the main institutions and organizations active in the field of improved agricultural implements and machinery.

2. Manufacturers/Suppliers/Importers/Distributors is presented in the main section sequence used in this book. Where we received general information we list the manufacturer's name and the general type of equipment they produce (their address appears in the index). We have also included suppliers, importers and distributors for countries where no manufacturing capacity exists. 'Export not available' does not mean that export control precludes the export of goods; the manufacturing capacity may be sufficient only for local requirements.

3. Written sources is a selective bibliography of the sources used when compiling the list of manufacturers which ITDG approached for information.

1. INSTITUTIONS AND ORGANIZATIONS

CANADA

International Development Research Centre (IDRC)
PO Box 8500
Ottawa
Ontario K1G 3H9.

FRANCE

Group de Recherches et d'Echanges sur les Techniques (GRET)
30 rue de Charonne
75011 Paris.

INDIA

Agricultural Tools Research Centre
PO Box 4
Bardoli 394 601
Gujarat.

Central Institute of Agricultural Engineering (I.C.A.R.)
Shri Guru Tegh Bahadur Complex
T.T. Nagur
Bhopal 462 003

Central Plantation Crops Research Institute
Kasaragod 670 124
Kerala.

International Crops Research Institute for the Semi Arid Tropics (ICRISAT)
Patancheru P.O.
Andra Pradesh 502 324.

ITALY

Food and Agriculture Organisation
Via delle Terme di Caracalla
00100 Rome.

NETHERLANDS

Institut voor Mechanisatie Arbied en Gebouwen (IMAG)
Postbus 43
6700 AA Wageningen.

International Reference Centre for Community Water Supply and Sanitation (IRC)
PO Box 93190
2509 AD The Hague.

Koninklijk Institut voor de Tropen (KIT)
Mauritskade 63
1092 AD Amsterdam.

TOOL
Entrepotdok 68a-69a
1018 AD Amsterdam.

NEW ZEALAND

New Zealand Agricultural Engineering Institute (NZAEI)
Lincoln College
Canterbury.

NZAEI (North Island)
Rukuhia
Hamilton.

NIGERIA

International Institute of Tropical Agriculture (IITA)
Oyo Road
PMB 5320
Ibadan.

PAPUA NEW GUINEA

South Pacific Appropriate Technology Foundation (SPATF)
PO Box 6937
Boroko.

PHILIPPINES

College of Engineering and Agro-Industrial Technology
University of the Philippines at Los Baños College
Laguna 3720.

International Rice and Research Institute (IRRI)
PO Box 933
Manila.

THAILAND

Asian Institute of Technology
PO Box 2754
Bangkok.

UNITED KINGDOM

International Bee Research Association
Hill House
Gerrards Cross
Buckinghamshire SL9 0NR

Intermediate Technology Power Ltd.
Mortimer Hill
Mortimer, Reading
Berks.

Intermediate Technology Transport Ltd.
The Old Power Station
Ardington, Oxon. OX12 8PH

National Institute of Agricultural Engineering (NIAE)
Wrest Park
Silsoe, Bedford MK45 4HS.

School of Veterinary Science
University of Bristol
Langford House, Langford
Bristol BS18 7DU

Silsoe College, Cranfield Institute of Technology
Silsoe, Bedford MK45 4DT.

Tropical Development Research Institute
56/62 Grays Inn Road
London WC1X 8LU.

Overseas Development Group
School of Development Studies
University of East Anglia
Norwich NR4 7TJ.

Wye College
Wye
Ashford

UNITED STATES OF AMERICA

Appropriate Technology International (ATI)
1331 H Street NW
Washington DC 20005.

International Plant Protection Centre (IPPC)
Oregon State University
Corvalis, Oregon 97331.

VITA
Suite 200
1815 North Lynn Street
Arlington, Va 22209.

Water and Sanitation for Health Project (WASH)
1611 N. Kent Street
Room 1002 Arlington, 22209.

2. MANUFACTURERS, SUPPLIERS, IMPORTERS, DISTRIBUTORS

A. Manufacturers

SEEDBED PREPARATION

HAND TOOLS

FRANCE

Experton Revollier
Saut du Tarn — Talabot

HUNGARY

Földesi Vegyesipari Ktsz
Szentendrei Vasipari Ktsz
Gyáli vas-és Vegyesipari Ktsz

INDIA

Agricultural Tools Factory
Tata Agricultural Co.

KENYA

Ideal Casements E.A. Ltd.

SIERRA LEONE

Tikonko Agricultural Ext. Centre

SRI LANKA

Sarvodaya Shramadana Movement (SSM)

ZAIRE

Umaz
Acmefon

ANIMAL-DRAWN PLOUGHS

FRANCE

Maupin Charrues
Codamm-Bajac

GHANA

Technology Consultancy Centre (export not available)

INDIA

Agricultural Tools Factory
Arthur Butler & Co.
The National Engineering Co.
Ravi Industries
Swastik Manufacture Co.

KENYA

Alaf Din Blacksmiths

SRI LANKA

Sarvodaya Shramadana Movement (SSM)

THAILAND

Ban Toom Industry
Mit Chareon Kasetphan Factory
Mit I-San Factory
Pitak Sunti-Methanikul
Plough Dl. Ban Tum
Mrs Samom Charun-on
Surin Iam-Maothavi
Tai Lek Chang
Tang Chin Seng
Mr Limsong Tuey
Yilun Chienkul

CULTIVATORS — ANIMAL-DRAWN

FRANCE

Maupin Charrues

INDIA

Agricultural Tools Factory
The National Engineering Co.
Ravi Industries
Swastik Manufacture Co.

NETHERLANDS

Coenders/Lot

LAND-FORMING EQUIPMENT

INDIA

Agricultural Tools Factory
— Ridging Ploughs
Arthur Butler & Co. Ltd.
— Ridging Ploughs
Swastik Manufacture Ltd.
— Bund Former/Ridging plough

HAND TRACTORS AND POWER TILLERS

FRANCE

Granja
Motostandard

INDIA

Alsales Ltd.
Essential Engineering Co.

INDONESIA

New Ruhaat Indonesia
P.T. Bina Pertiwi
Rukan Tani Trading

JAPAN

Maruka Machinery
Mitubishi Corporation
Nichimen
Nomura Trading
Sumitomo Corporation
Toyo Menka Kaisha Ltd

NETHERLANDS

Agrolang
Boeke-Heest
Cebeco-Hand
Dimag
Frapoma
Goma
Graaf
Horst
Intertool
Koop
Koppert
Lozeman
Lubbers/Ens
Markt
Nagel
Perrot
Peulen
Pool/Veldh
Weterings

SPAIN

Agria Hispania S.A.
Andres Hermanos S.A.
Cambyd S.L.
Cavadoras, LLAC
Construcciones Mecanicas 'BJR'
Industrias Mecanicas Condor
Industrias Mecanicas Palazon
Macaper
Mecanica Molion
Motocultores Pascuali S.A.
Motocultores Hersi S.L.
Motor Iberica S.A.
Motores Solo S.A.
Oval S.A.
·iva Motor S.L.
Raygar, S.A.
Talleres Bronco S.L.
Terbu S.A.
Truss S.L.

THAILAND

Boon Kong Kamchang Factory
Chamlong Kamchang Factory
Charoen Tractors
Charoenphan Factory
Chok Charoen
Chok Paiboon
Chow Thai Kam Chang
Farm Yuthana
Foo Heng Factory
Iamloo P
Kaen Mongkol Factory
Karunai Industrial Factory
Kasetchai Factory
Kit Chareon Factory
Lee Charoenmetre Factory
Lek Pairoj Factory
Mit Kaset Factory
Muang Loey Ruamchang Factory
Nok Noi — Kamkaset Factory
Piek Siam Kolkam
Prardityont Factory
Prasertsuwan Industry
Punnavithi Ruamkit Co. Ltd.
Rung Roj Factory
Sa-Ang Chareonkul
Saengthong-Kam Padit Factory
Sakdakarnchang Factory
Singku Industry
Thai Amorn Industry
Thai Kolkam
Wacharakam Factory
Wangdeelohakit
Wanpanich K Factory

INTERCULTIVATION

FRANCE

Gard, Ets
Burel, Ets
Agritom

HUNGARY

Gyáli Vas-és Vegyesipari Ktsz

INDIA

The National Engineering Co.
— Triphali
Ramakumar Industries
— animal drawn equipment
Swastik Manufacture Co.
— Wheel Hoe/Paddy weeders

NETHERLANDS

Coenders/Lot
— Single-/double-wheel hand hoe

SIERRA LEONE

Tikonko Agricultural Extn. Centre
— Push/pull hoe

SRI LANKA

Sarvodaya Shramadana Movement (SSM)

U.K.

Storage & Materials Handling Systems

ZIMBABWE

Columbus McKinnon
— Animal drawn equipment

PLANTERS AND SEEDERS

BOTSWANA

Rural Industries Innovation Centre
— plough planter

FRANCE

Audureau
— Animal drawn seeder
Burel Ets
— Manual and animal drawn seeder
Nodet-Gougis
— Animal drawn seeder
Prud 'Homme
— Plantmaster, Hand seeder

INDIA

Metal Industries
— Seed drills
Steel Engineering Corporation
— Sugarcane planter

JAPAN

Marubeni Corporation
— Rice transplanter
Maruka Machinery
— Rice transplanter

MALAWI

Brown & Clapperton
— Planters

NETHERLANDS

Botman
— Precision seed drills (hand pushed)
Hoopman
— Precision seed drills (hand pushed)

NIGERIA

Ela Agricultural Machinery Manufacturing & Engineering Co.
— Rolling injection planter 1- and 4-row models

SIERRA LEONE

Tikonko Agricultural Ext Centre
— Jab planter

SPAIN

The Technical Trading Co.

SRI LANKA

Sarvodaya Shramadana Movement
— Seed planters

USA

Coleman
— Garden plough
Cole Division

CROP PROTECTION AND OPERATOR SAFETY

Note: Manufacturers of sprayers and dusters, unless otherwise stated.

COLOMBIA

El Rodamiento

HUNGARY

Vegyépzer Tiszakécske

INDIA

Jardine Henderson Ltd.
Metal Industries

INDONESIA

C.V. Echo
P.T. Ektudju
P.T. Gemilang
P.D. Nusantara
N.V. Panca Ratna
P.T. Bina Pertiwi
P.T. Saga Utama
Toko Apollo

JAPAN

C. Itoh
Marubeni Corporation
Maruka Machinery
Nichimen
Nomura Trading
Sadoshima Metal
Sumitomo Corporation
Toyo Menka Krisha

KENYA

Hobra Manufacturing

NETHERLANDS

Agrar. Unie
Beek-Heyerm
— Bird scarer: acoustic
Botula
Brinkman
Dabekaussen
— Bird scarer: acoustic
Dekker/Etten
Embden
Empas
Euromac
Gielen
— Bird scarer: acoustic
Groenleer
Kobri
— Wheel driven push weed sprayer
Koster/Axel
— Bird scarer: acoustic
Leeuw
— Bird scarer: visual
Leperenburg
— Bird scarer: acoustic
Motrac
Nederkassel
— Wheel driven push weed sprayer
Osco
Schaap
Schrauwen
— Wheel driven push weed sprayer
Teeffelen
Themans
Tieman
Wild
Wit

WATER LIFTING

BANGLADESH

Essential Products Ltd
— Bangladesh New No.6 Pump
General Engineering & Foundry Works
National Iron Foundry & Engineering Works

DOMINICAN REPUBLIC

Equipo Technico Industrial
— AID/Battelle Hand pump/shallow well

FIJI

Nagan Engineering (Fiji) Ltd. ('not for export')
— Deep well hand pumps — 6'-100'

FRANCE

G. Bourrier
— Bourga VL 1000
Lelous-Sodia

HONDURAS

Fundicion y Maquinado
— Aid pump

INDIA

Voltas Ltd.
— Hand pumps

KENYA

Ibrahim N. Saksh
— Hand well pump

MADAGASCAR

Comptoirs Sanitaires de Madagaskar
— 'Mandritsa'

PHILIPPINES

Metals Engineering Resources
— Cast iron pump
Philippine Iron Manufacturing Co.
— Cast iron pump
Yamakiki Manufacturing
— Cast iron pump
Malanday Machinery & Manufacturing Corp.
— deep well hand pump
Atlantic Industrial Sales Corp
— deep well handpump
Makati Machinery & Equipment Co. Inc.
— deep well handpump

NETHERLANDS

WAGA Export
— "WAGA" handpump

SPAIN

Bombas Borja S.L.
— "Borja"

SRI LANKA

Sarodaya Shramadana Movement
— Hand pumps

TANZANIA

Morogoro Wells Construction Project
— 'SWN 80'
— 'SWN' 81

TUNISIA

Société les Fondières Réunies Tunisie
— 'AID'-type pump

HARVESTING AND THRESHING

EGYPT

Catholic Relief Service
— Thresher/winnower multi-cropper

FRANCE

Auge Ets
— Sickles, grass hooks, rakes
Mermier-Lemarchand
— Sickles, grass hooks, rakes
Saut du Tarn
— Sickles, grass hooks, rakes

GHANA

Technology Consultancy Centre ('not for export')
— Corn shellers, rice threshers

HUNGARY

Veszprémi Mezögép Vállalat
— Sheller

INDIA

Agricultural Tools Factory
— Sickles, Corn shellers, Paddy threshers
Elsete Industries
— Threshers
Essential Engineering Co.
— Reaper, thresher, shellers
Globe Educational
— Groundnut decorticator
Metal Industries
— Paddy thresher
Shree Bhuvaneshwari Industries
— Threshers
The National Engineering Co.
— Groundnut decorticator
Tractors & Farm Equipment
— Reapers (motorized)
Voltas
— Groundnut decorticator

INDONESIA

P.T. Daya Pioneer
— Reapers (motorized)

JAPAN

Marubeni Corporation
— Reapers (motorized)

MALAWI

Brown and Clapperton Group
— Shellers

NETHERLANDS

Botman
— Reapers (motorized)
Comtu-Beukel
— Reapers (motorized)
— post-harvest crop processing
Frapoma
— Reapers (motorized)
Heybroek
— Reapers (motorized)
Hock
— Reapers (motorized)
Lubbers/Ens
— Reapers (motorized)
Tuinlechniek
— Reapers (motorized)

SIERRA LEONE

Tikonko Agricultural Ext. Centre
— Rice threshers, winnowers, Hand maize shellers

THAILAND

Chai Amnat Karn Chang Factory
— Thresher
Kiet Panich Industrial
— Threshers
Lertchai Factory
— Corn shellers
Nan Ha Factory
— Corn shellers
Prasartporn Factory
— Corn shellers
Ruamkarnchang Factory
— Threshers
Saengyont K Factory
— Sugarcane cutter
Silip Charoen Factory
— Threshers
Thanya Engineering Factory
— Thresher
Yontkampanich Factory
— Corn shellers

USA

By Hand & Foot Ltd
— Scythe

ZAIRE

Chanimetal
— Herb-cutter
UMAZ
— Machetes

POST-HARVEST CROP PROCESSING

AUSTRALIA

Aust. Machine Group

BOTSWANA

Rural Industries Innovation Centre
— Sorghum de-huller
Unicon Pty. Ltd.
— Feed troughs

CHILE

Maestranza Sulza S.A.
Bittig, Boillat
— Mills, tanks, fans

COLOMBIA

Metalmecanicas Arrojo
— Chaff cutters (manual)

EGYPT

Catholic Relief Service
— Corn husker and sheller
— 10hp thresher

FIJI

Nagan Engineering (Fiji) Ltd ('not for export')
— 2/3 bladed chaff cutter — manual/motor driven

FRANCE

Agritom
Denis
— Cleaners and graders
S.A.M.A.S.
— Grain mills

GHANA

Technology Consultancy Centre ('not for export')
— Palm kernel cracker; Palm oil press; Gari plant; Corn mills

HUNGARY

Veszprémi Mezögép Vállalat
— Manual/motorized grape press; crushers; stemmers; grinders; choppers; grain grinders

INDIA

Swastik Manufacture Ltd.
— Chaff cutter

INDONESIA

C.V. Echo
— Rice polishers, hullers, mill

New Ruhaak Indonesia
— Driers
Rukan Tani Trading
— Hammermill

JAPAN

Marubeni Corporation
— Rice mill
Nichimen
— Rice mill
Nomura Trading
— Rice mill
Sumitomo Corporation
— Rice mill

MALAWI

Lilongwe Sheet Metal Ltd.
— Maize mill cyclone

PAPUA NEW GUINEA

Village Equipment Suppliers

PHILIPPINES

Poying Welding Shop
— Grain dryers

SIERRA LEONE

Tikonko Agricultural Ext. Centre
— Seed dresser; pre-cleaner
Cassava grater

THAILAND

Chin Charoen Yont
— Millsa
Chok Charoen
— Cassava mills
Kampaeng Pradit Factory
— Mills
Kietchai Industrial Factory
— Mills
Nan Ha Factory
— Mills
Phra Khiri Factory
— Mills
Pongcharoen Panichfactory
— Mills
Prasertpanich Factory
— Mills
Prayongkolkarn Factory
— Mills
Siamyont Factory
— Mills
Sri-U-Thon Karnchang Factory
— Mills
Sukpradit Industry
— Mills
T. Charoen Karnchang
— Mills
Yontkampanich Factory
— Mills
Yontneramit Factory
— Mills
Yontsaengthai Factory
— Mills

YUGOSLAVIA

Mio Standard
— Corn Sheller

ZAIRE

UMAZ
— Storage bins

TRANSPORT AND MATERIALS HANDLING

BOTSWANA

Unicon Pty. Ltd.
— Donkey cart

FRANCE

Agritom
Sodia-Leious
— Animal drawn carts

GHANA

Technology Consultancy Centre ('not for export')
— Bullock carts

INDIA

The Civil-Engineering Co.
— Wheelbarrows

MALAWI

Lilongwe Sheet Metal Ltd.
— Sack and wheelbarrows
Brown & Clapperton Group Ltd.
— Oxcarts
Chkupila Trailers (Ngulo) Ind.
— Oxcarts

SIERRA LEONE

Tikonko Agricultural Ext. Centre
— Wheelbarrows

THAILAND

Rung Roj Karn Pradit
— Trolley

ZAIRE

Chanimetal
— Wheelbarrow

UMAZ
— Wheelbarrows

ZAMBIA

Choma Auto Engineers
— Ox-drawn scotch carts

LIVESTOCK HUSBANDRY AND HEALTH

FRANCE

S.E.T.A. Eisenheim

HUNGARY

Bábolnai Mezögazdasági Kombinát
— Poultry & pig equipment
Bukisz Budapest Kisállatten Yésztö Általanos
— Poultry & rabbit equipment
Delta Ipari Szövetkezet
— Rabbit, poultry & pig equipment
Dunavarsányi 'Petofi' MGTSZ
— Rabbit equipment
Kiskörösi Vegyesipari Szövetkezet
— Rabbit, poultry & pig equipment
Környei Mezögazdasági Kombinát
— Poultry & pig equipment

JAPAN

Goto Hatchery
— Poultry equipment
J.P.J. Incubators
— Incubators

USA

Marting
— Mineral feeder

ZAMBIA

Choma Auto Engineers
— Branding irons; Cattle crushes

DAIRYING

HUNGARY

Veszprémi Mezögép Vállalat
— Milking machines & pails

KENYA

Industrial Plants E.A.
— General dairying equipment

MISCELLANEOUS

LAND CLEARANCE

FRANCE

Andelflex
— Brush cutters
Bernard Moteurs
— Brush cutters

GHANA

Technology Consultancy Centre ('not for export')
— Cutlasses

INDONESIA

P.T. Daya Pioneer
— Brush cutters

JAPAN

C. Itoh
— Brush cutters
Nomura Trading
— Brush cutters

NETHERLANDS

Embden
— Brush cutters
Hooyer
— Brush cutters
Intertool
— Brush cutters
Markt
— Brush cutters
Reesink
— Brush cutters

FENCING AND GATES

BOTSWANA

Unicon Pty. Ltd.
— Fencing and gates

NETHERLANDS

Groenleer
— Post hole augers
Lammerink
— Post hole augers
Marco/Klimaat
— Post hole augers
Perrot
— Post hole augers
Vledder
— Post hole augers
Z.V.H./Tem
— Post hole augers

SOIL BLOCK PRESSES

INDIA

Joshi Industries
— Soil block press

ADDENDA

HAND TOOLS

MADAGASCAR

S.I.D.E.M.A.

W. GERMANY

Schwäbische Hüttenwerke
— Spades, Shovels

PLOUGHS

KENYA

Kisumu Industrial Estate

WATER LIFTING

SRI LANKA

Ceygma Pumps

CROP PROCESSING

GHANA

Agricultural Engineers Ltd.
— Corn grinders

INDIA

Rajico International Div.
— Sugar cane crushers

LIBERIA

Agromachines Ltd.
— Rice hullers

TRANSPORT

SRI LANKA

Light Engineering Industries

B. Suppliers/Importers/Distributors

Bermuda

The following are major agricultural equipment importers for Bermuda. The information was supplied by the Dept of Agri. & Fisheries, Hamilton, Bermuda.

Astwood Cycles Ltd.
Flatts
Smith's

Bermuda Import & Export Co. Ltd.
Cnr King & Dundondald Streets
Hamilton

Gorhams Ltd.
St John's Road
Pembroke

Masters Ltd.
Bull's Head Park
Hamilton

Pearman, Watlington & Co. Ltd.
Pitt's Bay Road,
Pembroke

Kiribati

The following list of suppliers for Kiribati was provided by D. Pendle at the Ministry of Natural Resources Development, Kiribati.

AGENT

Chief Supply Officer
Supply Division
Bairiki
P.O. Box 71
Kiribati

Bairiki Holding Pty Co.
P.O. Box 36
Bairiki
Tarawa
Kiribati

SUPPLIERS

Multiplo Pty Ltd.
P.O. Box 314
Liverpool
New South Wales 2170
AUSTRALIA
(Building & equipment for livestock)

Mali

The following are all importers of agricultural equipment and the information was provided by the United Nations Development Programme, Bamako: Mali.

AFCO
BP 75
Bamako Tel: Bamako 22 39 59
(full range of equipment)

P.I.E.M.
BP 2116
Korofina
Bamako Tel: Bamako 22 37 82
(animal-drawn multipurpose tool bars)

SIMAGA
BP 1649
Bamako Tel: Bamako 22 47 69
(moderate range of equipment)

SOMEA
BP 724
Bamako Tel: Bamako 22 40 08
Telex: 460
(imports equipment from SISMAR, Senegal)

Zaire

The following organisation has supplied information on the agricultural equipment which they import in parts for manufacture and make-up in Zaire.

INZAL
BP 7121
Kinshasa
ZAIRE Tel: Kinshasa 77343
Telex: INZAL KIN 21406
(Disc ploughs, harrows, rotavators, rotary cutters, planters and post hole augers).

3. *WRITTEN SOURCES*

Agricultural Buyers' Directory, An annual guide to suppliers of equipment, materials and services for agriculture and for the primary processing of produce. **West Africa Farming & Food Processing,** Alain Charles, Bi-monthly magazine from Alain Charles House, 27 Wilfred Street, London SW1E 6PR.

Agricultural Machinery Manufacturers in Pakistan, National Agricultural Research Centre, P.O. National Institute of Health Islamasad, Pakistan.

Dunex Buyers Guide, Dun & Bradstreet (Israel) Ltd., 105 Hahashmonaim Street, Tel Aviv, Israel.

Appropriate Technology Directory, ATDA, P.O. Box 311 Gandhi Bhawan, Lucknow 226 001, U.P., India.

Australian Engineering Products and Services Export Directory, National Office, MTIA House, 214 Northbourne Avenue, Canberra ACT 2600, Australia.

Brazilian Agricultural Machines and Implements, ABIMAC/SIMESP Associacao Brasileira da Industria de Máquinas e Equipamentos. Sindicato da Industria de Máquinas de Estado de São Paulo, Viaduto Dona Paulina 80-16° Andar, 01595 São Paulo, Brazil.

Catalogue of Improved Agricultural Tools Implements and Equipment of India, Central Institute of Agricultural Engineering, Nabi Bagh, Berassa Road, Bhopal 46210, India.

Dairy Industries International Directory, Redman R. (ed) United Trade Press, 42/43 Gerrard Street, London W1V 7LP, U.K.

Dairy India, Gupta, P.R. (ed) Rekha Press, 2c/34 New Rontak Rd, New Delhi 110 005, India.

Directory of Agricultural and Forestry Equipment Manufacturers in Western Europe, European Directories, Volume 1: Europe. Volume 2: U.K. European Directors, 23 City Road, London EC1Y 1AA, U.K.

Directory of Institutions, and Individuals active in environmentally sound and appropriate technologies, United National Development Programme, UNDP Reference Series Vol.1, Pergamon Press, Oxford, U.K.

Equipment for Vegetable Production, Institute of Agricultural Engineering (IMAG), P.O. Box 43, 6700 AA Wageningen, The Netherlands.

Farm and Garden Equipment Guide, Agricultural Press Ltd., Surrey House, 1 Throwley Way, Sutton, Surrey, SM1 4QQ, U.K.

Farm Machinery Directory-Orange book, I.S.A.E. Indian Society of Agricultural Engineers, National Agro House, 2 Tansen Marj, 110 001 New Delhi, India.

The Green Book, 'the authority on tractors, farm & forest equipment', Industrial Newspapers Ltd., Queensway House, 2 Queensway, Redhill RH1 1QS, U.K.

Guide du Machinisme Agricole et Horticole en Belgique, Interfédérale du Machinisme Agricole Avenue Plasky, 30-Bte1, B-1040 Brussels, Belgium.

Guide to Technology Transfer in East, Central and South Africa, A Catalogue of Agricultural Equipment manufactured in the region with a guide to its purchase and use. Commonwealth Secretariat, Food Production and Rural Development Division, Marlborough House, London SW1Y 5HX, U.K.

Information Sources on the Agricultural Implements and Machinery, United National Industrial Development Organisation IMODP Guide to information sources No.8 UNIDO, Vienna, Austria.

Landmaschinen und Ackerschlepper, Lyoner Straße 18, Postfach 71 01 09, 6000 Frankfurt 71, West Germany.

Le Point sur Les Eoliennes de Pompage Dossier No.1, and Info. letter, GRET, Groupe de Recherche d'Exchanges Technologiques, 30 rue de Charonne, Paris, France.

Manual of Pesticide Application Equipment, I.P.P.C. International Plant Protection Centre, Corvallis, Oregan State University OR 97331, U.S.A.

Mechanisatiegids: directory of machinery and implements, IMAG P.O. Box 43, G700 AA Wageningen, Netherlands.

New Zealand National Agricultural Fieldays Catalogue, N.Z. National Fieldays Society, Mystery Creek, Hamilton, New Zealand.

The Power Guide. A Catalogue of Small-scale power Equipment, Intermediate Technology Development Group. Compiled by P. Fraenkel I.T.D.G. 9 King Street, London WC2E 8HW, U.K.

Regional Catalogue of Agricultural Implements, Regional Network for Agricultural Machinery, R.N.A.M., c/o UNDP, P.O. Box 7785 ADC, Pasay City, Philippines.

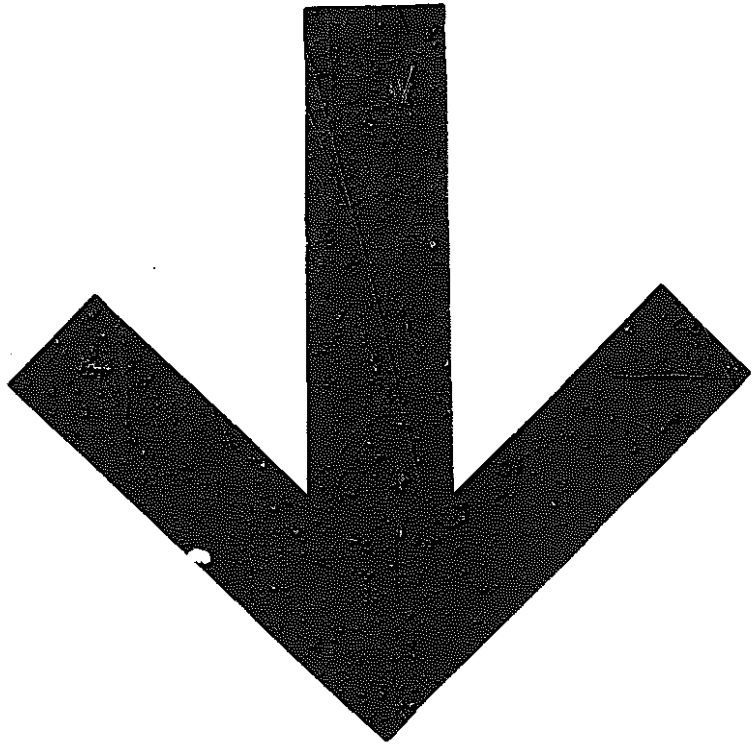
Rural Water Supply Handpumps Project: Laboratory testing of Handpumps for developing countries, World Bank, report Nos.1, 2 and 3. The World Bank, Washington, U.S.A.

Small Scale Farm Machinery Catalogue, Institute of Agricultural Engineering, P.O. Box BW 330, Borrowdale, Harare, Zimbabwe.

Testing and Evaluation and Modification Technical Reports Nos.11, 12 and 13, R.N.A.M. Philippines.

Tools for Homesteaders, Gardeners and Small-scale Farmers, A Catalogue of Hard-to-find Implements and Equipment. Rodale Press, Emmaus, U.S.A.

World Water, Monthly magazine from Thomas Telford Ltd., Telford House, PO Box 101, 26 Old Street, London EC1 U.K.



MANUFACTURERS INDEX

ARGENTINA

APISMAR, *226*
Calle 40, No.492
La Plata, (B.A.)

ARRIGUTTI CETTA, ENRIQUE F., S.A., *78, 79, 92*
Gregorio de Laferrere, 3210/12
1406 Capital Federal
Tel: 612-5657

BÁSCULAS LABRIOLA S.A., *195*
Calle de September y Deroui, 1560, e/11
1828 Badfield, (B.A.)
Tel: 242-7513

BOSIO, JUAN B., S.R.L., *198*
Chubut 772
2535 El Trébol, (Santa Fé)
Tel: 2192/2047
Cable: JUANBOSIO

BREJOV, MIGUEL A., *220*
Nazca 4058/74
1419 Buenos Aires
Tel: 572-3443

"EL PANAL", *220*
S.A.C.I.F.I.Y.A.
Humahuaca 4229
1192 Buenos Aires
Tel: 86-1562/3238

FÁBRICA DE IMPLEMENTOS AGRÍCOLAS (FIASA), *101, 107, 110, 113*
Horiguera 1882
1406 Buenos Aires
Tel: 923-1055
Telex: 22910 CAMEX AR

GHERARDI E HIJOS S.A., *16, 176, 234*
Florida 520, 300F, 318
1005 Buenos Aires
Tel: 393-9146
Cable: GHERARDI, CASILDA
Telex: 23614 GHEBA AR

INDUSTRIA METALÚRGICA, *110*
J.A. Saglio S.A.
1460 — Bdo De Irigoyen
1470 Buenos Aires

MECANIZACIÓN APÍCOLA SRL, *220*
Calle 35, No.407
La Plata, (B.A.)

LABOULAYE, *89*
(Through Technical Assistance, West Germany)

TERZA HNOS., *220*
S.A.C.I.F.I.Y.A.
Floor 5, Corrientes 1312
1043 Buenos Aires
Tel: 49-7185/2284
Cable: DETERZA BAIRES

AUSTRALIA

AIR SHEARING PTY. LTD., *210*
11 River Road
Bayswater
W.A. 6053

ALLBULK AGRICULTURAL EQUIPMENT, *208*
Boothenba Road
Dubbo
N.S.W. 2830

ALSTON WINDMILLS PTY. LTD., *110*
Branthome Street
Gisborne
Victoria

AUSTRALIAN AGRICULTURAL MACHINERY GROUP PTY. LTD., *154, 208, 239*
73 Abernethy Road
P.O. Box 157
Belmont
W.A. 6104
Tel: 277-1555/4677
Cable: JETSTREAM & ALLBULK

BATESCREW ENGINEERING PTY. LTD., *112*
Deniliquin Street
Tocumwal
N.S.W. 2714
Tel: TOCUMWAL 101 & 281
Telex: AA 56087

BORAL CYCLONE LTD., *13, 16, 37, 38, 176, 208, 211, 234*
221-223 East Boundary Road
P.O. Box 77
East Bentleigh
Victoria 3165
Tel: 579-1777
Telex: AA 36016
Cable: SCREENWIRE MELBOURNE

'COMET' SIDNEY WILLIAMS & CO. LTD., *110*
P.O. Box 22
Dulwich Hill
N.S.W. 2203

DANKS, JOHN & SON, PTY. LTD., *109*
Doody Street
Alexandria
Sydney
N.S.W.

FARMERS' GRAZCOS CO-OP, *192*
5 Spring Street
Sydney
N.S.W. 2000
Tel: (02) 241-2441

GUILFOYLE, JOHN L. (SALES) PTY. LTD, *220*
772 Boundary Road
P.O. Box 18
Darra
Brisbane
Queensland 4076
Tel: (07) 372-3677

GUTHRIE TRADING PTY., *197*
240 Currie Street
Adelaide
S.A. 5001

METTERS, M.B.P., (W.A.) PTY. LTD., *110*
Salvado Road
Wembly
W.A. 6014

MONTEATH, R.E., *209*
George Road
PO Southland
Tel: KAP-387 Invergill
KAP-829

NEWMAN SHEARING EQUIPMENT, *209*
45 Gertrude Street
Fitzroy
Victoria, 3065
Tel: 419-6502
Home: (045)25-5558

PAYNE, DAVID, & CO., *208*
255 Star Street
Welshpool
W.A. 6106

PEDERICK ENGINEERING, *208*
90 Tudhoe Road
Wagin
W.A. 6315

PENDER BROS. PTY. LTD., *220*
Elgin Street
P.O. Box 20
Maitland
N.S.W. 23200
Tel: 33-6666
Cable: PENBROS

SOLAREX PTY. LTD., *109*
5 Bellona Avenue
Regents Park 2143
N.S.W.

SOUTHERN CROSS, TOOWOOMBA FOUNDRY PTY. LTD., *110*
259 Ruthven Street
Toowoomba
Queensland 4350
Telex: 40046

STRUCTURES PTY. LTD., *208*
Bennet Avenue
Edwardstown
S.A. 6039

TROJAN PTY. LTD., *14, 16, 37, 38, 174, 176, 177, 234*
38 Raleigh Street
Footscray
Victoria 3011
Tel: 689-3377
Telex: BRSPRING AA 31705
Cable: TROJANTOOL MELBOURNE

VARCOE, CHAPMAN & SAUNDERS PTY. LTD., *110*
Crouch Street
Mount Gambier
S.A. 5290
Telex: 80059

VERMEEREN BROS. ENGINEERING, *208*
26 Wynarling Road
Keith
S.A. 5267

WALSTER, A.J., & SON, *208*
Jaffre Street
Junee
N.S.W. 2593
Tel: (089) 24-1004

WILLETTON ENGINEERS, *208*
13A Davison Road
Maddington
W.A. 6109

WOOLCOCK ENGINEERING, *209*
P.O. Box 79
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S.A. 5203
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8011 Graz
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4600 Wels
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Telex: 025539
Cable: REFORMWERKE WELS

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Hunold Straße 3
6020 Innsbruck

VEREINIGTE EDELSTAHLWERKE, *105*
Postfach 56
Franz Josefs-Kai 51
1011 Vienna

BANGLADESH

ENGINEERS WOOD STEEL INDUSTRIES, *101*
67 Tejgaon Industrial Area
Dhaka 8

ESSENTIAL PRODUCTS LTD., *239*
166 Rayer Bazar
Dhaka

GENERAL ENGINEERING & FOUNDRY WORKS, *239*
199 Nawabpur Road
Dhaka

NATIONAL IRON FOUNDRY & ENGINEERING WORKS LTD., *239*
Station Road
Khulna

MIRPUR AGRICULTURAL WORKSHOP & TRAINING SCHOOL (MAWTS), *100*
Mirpur Section 12
Pallabi
Dhaka 16

RANGPUR DINAJPUR REHABILITATION SERVICE, *100, 101*
House 16, Road 16 (New)
Dhanmondi RA
Dhaka
Tel: 317872/310509

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RAJICO INTERNATIONAL DIV., *240*
204 Pragati House
47-48 Nehru Place
New Delhi-110019
Tel: 6411791
Telex: 31-61192 RJCO
Cable: RAJIEQUIP

RAMAKUMAR INDUSTRIES, *238*
G.N. Mills Post
Coimbatore 641 029
Tamil Nadu
Tel: 23959
Cable: FURROW

RAVI INDUSTRIES, *238*
172-A Abu Lane
Meerut Cantt

RAWAT APIARIES (HIMALAYAS), *220, 222, 225*
Ranikhet Dist.
Almore U.P.

RAYLONS METAL WORKS,
Kondivitta Lane
J.B. Nagar Post Office
Andheri
Bombay 400 059
Tel: 6325932/6323288
Cable: BLANCHING BOMBAY 400023 INDIA

RICHARDSON & CRUDDAS (1972) LTD., *103*
P.O. Box 1276
Madras 600 001
Tel: 22401
Telex: 041-7128
Cable: IRONWORKS

RUSTOM TRACTORS MANUFACTURING CO., *30*
Delhi Road
Bahadurgarh 124 507
Distt. Rohtak
Haryana
Tel: 83249

S.P. ENGINEERING CORPORATION, *158, 160*
P.O. Box 218
79/7 Latouche Road
Kanpur 208 001
Tel: 64252/64253
Telex: 0325 313 SPKP
Cable: SAJAN

INDIA contd.

SARVODAYA SAMITI, 220
Gandhinagar Koraput 764 020
Orissa

SENCO INDUSTRIES, *103*
A-12, Coimbatore Private Ind. Estate
Coimbatore 641 021

SHOLAPUR WELL SERVICE, *103*
560 59 South Sadar Bazar
Civil Lines
Sholapur 413 003
Maharashtra
Tel: 2583
Cable: WELLSERV 413003

SIGMA STEEL INDUSTRIES (REGD.), *78, 79, 80, 84, 85, 90*
A-2 Industrial Estate
Ludhiana 141 003
Punjab
Tel: 23839/31843/29545/25871

SINGH METAL CASTING WORKS, *109*
110-D Nirala Nagar
Lucknow

SINGHAL UDYOG (REGD.), *199*
363 Azad Market
P.O. Box 1037
Delhi 110 006

SOHAM ENGINEERING CORPORATION, *103*
Gurudev Engineering Co.
1-7-1054 Industrial Area
Azambad
Hyderabad 500 020
Andhra Pradesh

SONTHALIA INDUSTRIES, *103*
23-24 Radha Bazar Street,
3rd Floor
Calcutta 700 001

SREE BHUVANESHWARI INDUSTRIES M/S., *239*
168 C Avanashi Road
Peelamedu
Coimbatore 641 004

SRI LAKSHMI ENTERPRISES, *55*
65-1 1st Main Road
Ramchandra Puram
Bangalore 560 021

STANDARD AGRICULTURAL ENGINEERING CO., *22, 131, 136*
824 & 825 Industrial Area B
Ludhiana 141 003
Punjab
Tel: 37667
Cable: SAECO

STEEL ENGINEERING CORPORATION, *238*
Lohani Marg
Saharnpur

SURAYA BHARAT INDUSTRIES, *103*
58 Craftsmen Guild
Mallepally
Hyderabad 500 047
Andhra Pradesh

SWASTIK MANUFACTURERS LTD., *238, 239*
128-B Mahatma Gandhi Road
Secunderabad

TAMIL NADU SMALL INDUSTRIES CORPORATION (TANSI), *103*
1 Whites Road
Madras 600 014
Tamil Nadu

TATA AGRICULTURAL CO., *237*
P.O. Box 581
New Delhi

THERMAX (INDIA) PVT. LTD. *147, 149, 150*
Thermax House
4 Bombay Pune Rd.
Shivajinagar
Pune 411 005
Tel: 0212 51125
Telex: TMAXIN 0145 545 TMXS IN
Cable: THERMAX HO

TRACTOR & FARM EQUIPMENT LTD., *239*
205 Mount Road
Madras

TRIPURA STATE KHADI & VILLAGE INDUSTRIES BOARD, *220*
Post Agartala 799 001
Tripura

UNION FORGINGS, *17, 21, 22, 24, 40, 42, 43, 127, 131, 134, 136, 158, 163*
Focal Point
Sherpur
Ludhiana
Punjab
Tel: 23636

UNION TRACTOR WORKSHOP, *130, 131*
8-B Phase 11
Maya Puri Industrial Area
New Delhi 110 064
Tel: 504615
Cable: AGROMECH-NEW DELHI

VARUN ENTERPRISES, *103*
27-28-29 M.P.L.U.N. Sheds
Govindpura Industrial Estate
Bhopal
Madhya Pradesh

VARUN ENTERPRISES, *103*
17-19 Parvati Nagar
Tonk Fatak
Jaipur 302 004
Rajasthan

VOLTAS LTD., *55, 110, 239*
Agro-Industrial Division
19 JN Heredia Marg
P.O. Box 900
Bombay 400 038
Tel: 268131
Telex: 2239
Cable: VOLTAIP

VICON LTD., *54, 132*
K.R. Puram-Whitefield Road
Mahadevapura Post
Bangalore 560 048
Karnataka
Tel: Whitefield 217
Cable: VICONTACT — BANGALORE
Telex: 0845 317

V.S.T. [illegible] TRACTORS LTD., *29*
1 Dy[illegible] Industrial Layout
Whitefield Road
P.O. Box 4801
Mahadevapura PO
Bangalore 560 048
Tel: 58205-7
Cable: POWERTILER

WEST BENGAL AGRO-INDUSTRIES CORPORATION LTD., *17, 39, 41, 62, 78, 79, 80, 84, 100, 111, 127, 129, 131*
23B Netaji Subhas Road, 3rd Floor
Calcutta 700 001
Tel: 22-9402
Cable: AGRINPUT

WIND MACHINES AUTO SPARE INDUSTRIES, *110*
Wind Machines Division
C-7 Industrial Estate
Pondicherry 605 009

YANTRA VIDYALAYA, *100*
P.O. Box 4
Bardoli 394 601
Gujarat

YESHWANT MECHANICAL WORKS, *156*
Kelkar Compound
Dahanu Road 401 602
Maharashtra

INDONESIA

AGRINDO, P.T., *132, 156*
Desa Bambe Kab. Gresik
Jawa-Timur

CELCO INDUSTRIAL CO., *104*
43A Jendral Gatot Subrato
Bandung

BINA PERTIWI, P.T., *238*
Jl. Ir. H. Juanda 111/8
Jakarta
Tel: 350 205

BINA PRODUKSI TANAMAN PANGAN, DIT., *23*
Pasar Minggu
Jakarta

BIRO TEKNIK M. DJUPRI, *84*
Jalan Ronggowarsito
Solo

BLIMA BARU, P.T., *78*
Jl. Brig. Jend. Sudiarto
Solo Jawa

BLIMBING, U.D., *39*
Malang

BUMA SAKTI, P.T., *23, 131*
Jl. Suriana 8
Bandung

DAYA PIONEER INT. P.T., *239, 240*
Jl.IR.H. Juanda 41
Jakarta
Tel: 376 308
Telex: 461333JKT

ECHO, C.V., *238, 239*
Jl. Pangeran Jayakarta No. 141
Block 11/2/22
Jakarta
Tel: 620 409

EKTUDJU, P.T., *238*
Jl. Riau 59-61
Medan
Jakarta
Tel: 326 277

GEMILANG CORP. P.T., *238*
Jl. Palatehan 1/32/33
Jakarta

KERTA LAKSANA, P.T. [illegible], *154, 161*
Jl. Jenderal Sudirman [illegible]
Bandung

METAL INDUSTRIES DEV. CENTRE, *23, 64, 128*
Jalan Sangkuriang 12
P.P. Box 113
Bandung
Tel: 81171
Cable: MIDCINDO BANDUNG INDONESIA

MUSUHAMA, C.V., *23, 39, 78, 127*
Jl. Raya Kajen 248
Tegal
Jawa

MUTOF, C.V., *78*
Jl. Raya Lemah Duwur r
Adiwerna Tegal

NEW RUHAAT INDUSTRIES, *238, 240*
Jl. Pintu Besar Utara 11
Jakarta
Tel: 676 526
Telex: 42048 NRI JKI

NUSANTARA, P.D., *238*
RP Hayam Wurukingdah AA 1-2
Jl. Hayam Wuruk
Jakarta
Tel: 675 596

PANCA RATNA, N.V., *238*
Jl. Bangunan Timur 7
Rawamangun 11 Blok A
Jakarta
Tel: 485 501

PURNA SADHANA, P.T., *78, 84*
Jl. Asia Afrika 150
Bandung

RUKAN TANI TRADING, *238, 240*
Jl. Gajah Mada 156-B
Jakarta
Tel: 623 708

SAGA UTAMA, P.T., *238*
25 Jl. Prapatan
3rd Floor 6
Jakarta
Tel: 373 046
Telex: 45374 SAGA IA
Cable: SAGAUT

TOKO APOLLO, *238*
Petak Baru No.23
Jakarta
Tel: 673 051
Telex: 41597 APOLLO LA

YANMAR AGRI M/C, P.T. (YAMINDO, P.T.), *29, 132*
42 Jl. Ir.H. Juanda
P.O. Box 4135/JKT
Jakarta
Tel: 363 814/366 237
Cable: YAMINDOPT JAKARTA

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IRISH AGRICULTURAL WHOLESALE SOCIETY LTD., *220*
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Dublin 8
Tel: 717131
Telex: 5298
Cable: PRODUCE DUBLIN

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Magcromtha
Co. Chorcaighe
Baile Muic ire 21/64

SOUTHERN STEEL WORKS LTD., *110*
Ballyhale
Co. Kilkenny
Tel: 056 28633

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B.F. EQUIPMENT, *61*
30080 Sde Yaakov
Tel: (04) 932636
Telex: 46400 BXHA-IL Ext 8067

KISLUK, A., *149, 155*
Industrial Zone
P.O. Box 195
Afula Elit 18101
Tel: (065) 923767
Telex: 45181 ARAN IL ATTN KISLUK 144

LERNER & BAR ENGINEERING CO., *193*
P.O. Box 11457
Tel Aviv 61113
Tel: (03) 39143

NIR-DAVID-METAL WORKS, *80, 88, 90*
Mobile Post
Gilboa 19150
Tel: (065) 86315/87688
Telex: 46832 ND IL

PLASSON PLASTIC PRODUCTS (1972), *193*
DN Menashe 37, 805
Tel: (063) 90881
Telex: 46221
Cable: PLASMAG ZIKHRON YAAOOV

TECHNOHAC AGRICULTURAL MACHINERY & IMPLEMENTS LTD., *62, 66, 80, 90*
New Industry Region
P.O. Box 225
Petakh-Tikva
Tel: 921198
Telex: 341118-9 FOR 5270
Cable: TECHNOHAC PETAKH TIKVA

YODLA, DOV & SONS, *21, 22, 23*
P.O. Box 246
Givatayim 53102
Tel: (03) 960234/5
Telex: 34118 BXTV IL Ext 5932

ITALY

ALPINA, *125, 232, 233*
31015 Conegliano
Treviso
Tel: (0438) 40141
Telex: 410567 ITALY

ANSALDO (SOCIETA GENERALE ELETTROMECCANICA SpA, *109*
Via Nicola Lorenzzi 8
16152 Genova
Cornigliano

AZA INTERNATIONAL S.R.L., *194*
Via Spluga 52
22052 Cernusco Lombardone (Como)
Tel: (039) 582 273/593 424
Telex: 333127 INAZAI

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Via Circonvallazione 19
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Vicenza
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Telex: 480609 BF SPA I

BERTANI, R. & F., *78, 79, 80, 83, 87, 88*
Via Leonardo da Vinci, N.41
20081 Abbiategrasso
Milano
Tel: (02) 94662/2223
Telex: 314383 BEPUMP I

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Via Guicciardi 7
42100 Reggio Emilia
Tel: (0522) 91000
Telex: 530662 BERMA I

BIANCHI S.R.L., *68*
Via Matteotti 60
26034 Piadena
Cremona
Tel: (0375) 98237
Telex: 312231 ASSIND-I-BIANCHI

CARPI, F.LLI GIACOMO & LUIGI, *80, 83, 84, 87, 88, 111*
42028 Poviglio
Via Romana 82-R.E.
Tel: (0522) 68 97 41
Telex: 530279 CARPI I

CEAF, *16, 37, 38, 174, 176, 177, 178, 198, 234*
S.N.C. Fili Siletti
24034 Cisano
Bergamasco
Tel: (035) 781078

CIFARELLI RAFFAELE, *80*
Strada Onolo 124
27058 Voghera
Tel: (0383) 48938

FALCI, *122*
Via Cuneo 3/5/7
12025 Dronero (CN)
Tel: (0171) 918106/7/8
Telex: 21 24 51 FALCI I

FERRARI, O.M. SpA, *26, 28, 126*
Via Valbrina 19
42045 Luzzara (RE)
Tel: (0522) 835524
Telex: 530144 FERMAC I

FLUXINOS, *105*
Apparecchiature dei Fluidi
Via Genoa 10
58100 Grosseto
Tel: (0564) 451272
Telex: 624043 AINGROL

GOLDONI SpA, *27*
41012 Migliarina di Carpi
(Via Canale 3)
Modena
Tel: (0522) 699240
Telex: 530023 GLDNI
Cable: TLX 530023 GLDN I CARPI

LEGA SDF, *220, 222, 224*
Via de Crescenzi 18
48018 Faenza
Tel: (0522) 699240
Telex: 530023 GLDNI
Cable: TLX 530023 GLDN I CARPI

LOWARA SpA, *109*
36075 Montecchio Maggiore
Vicenza

M.A.B. DI GUIDO BOCCHINI, *26, 28, 125*
Via Erbosa
47030 Gatteo (FO)
Tel: (0541) 930404
Telex: 550884 MABAGRI

NARDI FRANCESCO & FIGLI, *17, 19, 20, 22, 66, 161, 162*
06017 Selci Lama
Perugia
Tel: (075) 8582180
Telex: 660074 NARDI I
Cable: NARDI/LAMA/PERUGIA

P.G.S. SpA, *28*
29010 Cadeo
Piacenza
Tel: (0523) 50321
Telex: 530134 PGS I
Cable: PIGIESSE PIACENZA

PASQUALI SpA, *26, 126*
Via Nuova 30
50041 Calenzano (Firenze)
Tel: (055) 8879541
Telex: 581431 PAMA 1
Cable: PAMA CELENZANO

RUGGERINI MOTORI, *111*
42040 Villa Bagno (Reggio Emilia)
Tel: (0522) 55221
Telex: 530321 MOTRUG

SAF s.n.c., *220, 229*
Via Liguria 17
36015 Schio (VI)
Tel: (0445) 21787

S.E.P., *26, 28, 126*
Fabbrica Macchine Agricole s.r.l.
42018 S. Martino In Rio (RE)
Tel: (0522) 698000
Telex: 531 055 SEP I

IVORY COAST

ABIDJAN INDUSTRIES S.A., *104, 106*
B.P. 343
45 rue Pierre et Marie Curie
(Zone 4c) Abidjan
Tel: 354560
Telex: 2377/3944 (SHELL CI)

SAFICOCI, *104*
B.P. 1117
Abidjan

JAPAN

AKITAYA HONTEN CO. LTD., *220*
Kano-Fuji-Machi
Gifu 500

ARIMITSU INDUSTRY CO. LTD. *80, 82, 83, 84*
3-21 Fukaekita 2-chome
Higashinari-Ku
Osaka 537
Tel: (06) 976-8181
Telex: 0-529-7257 ARIMIT J
Cable: ARIMITIND OSAKA

CECOCO, *20, 39, 42, 63, 84, 89, 109, 124, 127, 129, 133, 137, 147, 148, 150, 151, 152, 155, 156, 157, 158, 160, 161, 163, 235*
P.O. Box 8
Ibaraki City
Osaka 567
Tel: (0726) 22-2441
Telex: J 65910 CECOCO
Cable: CECOCO IBARAKI OSAKA

COSMO INCORPORATED, *13, 16, 30, 37, 172, 176, 177, 178, 179, 180, 209, 233*
Towa Bldg. 4th Floor
10 Awaji-Machi 4-chome
Higashi-Ku
Osaka
Tel: 227-0707
Telex: COSMO J 64568
Cable: COSMOINCORP OSAKA

EBARA CORPORATION, *109*
Asahi Building
6-7 Giuza 6-chome
Chuo-Ku
Tokyo 104
Telex: 26976

FURUZAWA BEE KEEPING MANUFACTURER, *220*
752 Gifu

GIFU YOHO CO. LTD., *220, 229*
Kano-Sakurada-Cho 1
Gifu-Shi Gifu 500-91
Tel. (0582) 713838

GOTO HATCHERY INC., *240*
Nishing-Machi 7-chome
Gifu-Pree

HATSUTA INDUSTRIAL CO. LTD., *78, 79, 80, 82, 84, 85, 88*
4-39 Chifune 1-chome
Nishiyodogawa-Ku
Osaka
Tel: (06) 471-3359
Telex: J64557 HATSUTA

ITOH, C., & CO. LTD., *239, 240*
Central P.O. Box 136
Tokyo 100-91
Tel: (03) 497-2380
Telex: 242563 ITOHCHU/TOKAU SCT

J.P.J. INCUBATORS MRG. CO., *240*
34 Ota-Cho 4-chome
Mizuho-Ku
Nagoya 467

KANEMATSU-GOSHO LTD., *28, 29*
Central P.O. Box 103
Nagoya 450-91
Telex: 442 2330
Cable: KANEGOLD

KAWAMOTO PUMP MFG. CO. LTD., *102, 106*
P.O. Box Nagoya Naka No. 25
Nagoya
Tel: 251-7171 (Nagoya)
Telex: 4422321 KAWA J
Cable: KAWAMOTOPUMPNAGOYA

KIORITZ CORPORATION, *78, 79, 80, 83, 84, 89*
5-1 Shimorenjaku 7-chome
Mitaka
Tokyo 181
Telex: 2822-311 KIORIT J
Cable: KYORITSU MUSASHINO-MITAKA

KUBOTA LTD., *27, 80, 84, 126, 233*
2-47 Shikitsuhigashi 1-chome
Naniwa-Ku
Osaka 556-91
Tel: (06) 648 2159
Telex: 526-7785 KUBOTA J
Cable: IRONKUBOTA OSAKA

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Osaka 540
Tel: (06) 941 0271
Telex: 529 6564

MARUNAKA SPRAYER & DUSTER MFG. CO. LTD., *78, 79, 80, 82, 83, 84, 88*
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Kisshoin
Minamiku, Kyoto
Tel: (075) 321-1901
Telex: 5423339 MARNAK J
Cable: MARUNAKA KYOTO

MITSUBISHI CORPORATION, *238*
Central P.O. Box 22
Tokyo 100-91
Tel: (03) 210-2121
Telex: MITUBISI J 22222-5

NICHIMEN CO. LTD., *238, 239, 240*
11-1 Nihon Bashi 3-chome
Chuo-Ku
Tokyo 103
Tel: (03) 277-5111
Telex: J22329 (NICHIA)

NITTO SEISAKUSHO CO. LTD., *78, 79, 80, 84, 85*
29-23 Noe 3-chome
Jyotoku
Osaka
Tel: Osaka (06) 376-0757
Telex: 5236878 DAIDO J
Cable: NITTO SPRAY OSAKA

NOMURA TRADING CO. LTD., *238, 239, 240*
Shin-Yaesuguchi Blag
2-1 Yaesu 2-chome
Chuo-Ku
Tokyo 104
Tel: (03) 277-4680
Telex: J22396

NONOGAKI APIARY, *220*
Oku-Machi
Ichinoabuyo-Shi 490-02 Maya

OHASHI AGRICULTURAL MACHINERY MANUFACTURING CO. LTD., *28*
Jojima-cho, Mizuma-gun
Fukuoka-ken 830-02
Tel: (09426) 2-3161
Telex: 742834 HIFAX

OHMAE MANUFACTURING CO. LTD., *82*
21-1 Akabane 3-chome
Kita-Ku
Tokyo
Tel: Tokyo 901-5151

SADOSHIMA METAL CO. LTD., *239*
7 Unagioani-Higashinocho
Minami-Ku
Osaka 542
Tel: (06) 244-5576
Telex: J64728 (SADO)

SHARP CORPORATION, *109*
22-22 Nagaike
Abeno-Ku
Osaka 545

SUMITOMO CORPORATION, *238, 239, 240*
New Sumitomo Shoji Bldg.
2-2 Hitotsubashi 1-chome
Chiyoda-Ku
Tokyo 100
Tel: (03) 436-0201
Telex: 242 3218 SOBUCOJ

SUZUE AGRICULTURAL MACHINERY CO. LTD., *27, 29, 127*
144-2 Gomen-cho
Nankoku-Shi
Kochi-Ken 783
Tel: (06) 541-5121
Telex: J63115 NISTX

TAIWA NOKI CO. LTD.,
43 Seki-Machi
Toyama-City
Tel: (0764) 29-4584

TOYO MENKA KAISHA LTD., *238, 239*
14-27 Akasaka 2-chome
Minato-Ku
Tokyo 107
Tel: (03) 588-7117
Telex: J22421

YAMAMOTO MFG. CO. LTD., *147, 163*
813-17 Tendo-Ko
Tendo-Shi
Yamagata Ken 994
Tel: Tendo (02365) 3-3411
Telex: 8722 66 YMCTND J
Cable: YAMAMOTOTENDO. YAMAGATA

KENYA

ALAF DIN BLACKSMITHS, *238*
P.O. Box 45653
Duruma Road
Nairobi

ANIMATICS LTD., *190, 199*
P.O. Box 72011
Enterprise Road
Busia Road Corner
Nairobi
Tel: 555469/557041
Cable: ANIMATICS NAIROBI, KENYA

ATLAS COPCO (KENYA) LTD., *102, 104*
P.O. Box 40090
Nairobi
Tel: 557120/558128
Telex: 22341 ATCOKEN
Cable: ATCOKEN

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Farmer Training Centre
Mola

HARRIES, BOBS, ENG. LTD., *110*
P.O. Box 40
Daramaini Estate
Thika

HOBRA MANUFACTURING LTD., *78, 79, 239*
P.O. Box 18242
Homa Bay Road
Nairobi
Tel: 556216/554765
Cable: KLEENCHEM

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P.O. Box 70
Kericho

IDEAL CASEMENTS E.A. LTD., *16, 19, 43, 132, 234, 237*
P.O. Box 45319
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Nairobi
Tel: 555599
Telex: IDEASMENT

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Kampala Road
Nairobi

K. KAY ENGINEERING, *159*
Box 18464
Nairobi
Tel: Nairobi 558788
Telex: 22772
Cable: KAYENG NAIROBI

KENYA ENG. INDUSTRIES, *122, 175, 234*
P.O. Box 78052
Lokitaung Road
Off Likoni Road Ind. Area
Nairobi
Tel: 554180
Telex: 22866
Cable: LOCKS

KISUMU INDUSTRIAL ESTATE, *240*
P.O. Box 467
Kisumu

LEADING ENGINEERING, *163, 192*
P.O. Box 42131
Bandari Road
Nairobi
Tel: 558296

LUGARI EXTENSION PROGRAM, *18, 21, 42, 180*
Appropriate Implements Project
P.O. Box 125
Soy

MAMUKI INDUSTRIES, *19, 44*
P.O. Box 88
Ruiru
Tel: 22464

MINISTRY OF AGRICULTURE & LIVESTOCK DEVELOPMENT, *220, 222*
Beekeeping Branch
P.O. Box 68229
Nairobi

NDUME PRODUCTS LTD., *61, 108, 133, 151*
P.O. Box 62
Gilgil
Tel: 245
Telex: 39801 GILGIL

RELIANCE ENGINEERING WORKS LTD., *154, 162*
P.O. Box 197
Kisumu
Tel: 2092

KOREA

All equipment manufactured in Korea which is mentioned in this Guide is marketed through the Korea Trade Promotion Corporation. For readers' information references to the individual factories are also provided.

KOREA TRADE PROMOTION CORPORATION, *16, 26, 27, 37, 80, 111, 127, 130, 150, 157, 163, 176, 199, 233, 234*
C.P.O. Box 1621
Seoul
Tel: 753-4180/9
Telex: KOTRA K23659 K27326
Cable: KOTRA SEOUL

AN AM CORPORATION, *16, 37, 176*
C.P.O. Box 3872
Seoul
Tel: 261-0108/9
Telex: K24310 KOMELON ATTN. AN AM
Cable: DOUBLEA SEOUL

ASIA IND. CO. *27, 80, 163*
C.P.O. Box 5046
Seoul
Tel: 562-8098/9095
Cable: ASIA KIM SEOUL

BOOK SUNG MACHINERY IND. CO. LTD., *163*
219-10 Seocho-dong
Gangham-kn
Seoul
Tel: 562-3605

CHANG SIN IND. CO. LTD., *16, 176*
P.O. Box 93
Daejeon
Tel: (042) 22-0109/7240 (Dagion)
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Tel: 966-7575/967-0756

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Batu 8 Jalan Rawang
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3512 HM Utrecht
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2690 AA 'S-Gravenzade
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Telex: 46530 FARMXNL

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Manila
Tel: 396528

ISAROG INDUSTRIES, *129*
826 Renacimiento Street
Tabico
Naga City
Camarines Sur

JCCE INDUSTRIES, *64, 87, 125, 129, 130, 147, 148*
242 Mayondon
Los Baños
Laguna
Tel: 50011
Cable: JCCE. COLLEGE, LAGUNA, PHIL

JAMANDRE INDUSTRIES, *129, 130*
88 Rizal Street
La Paz
Iloilo City

JASPE METALCRAFT, *129*
Evangelista Street
Pavia
Iloilo City

KABACAN ENGINEERING WORKS & SERVICES, *126*
Rizal Avenue
Kabacan
North Cotabato

KALAYAAN ENGINEERING CO. INC., *100*
4255 Emilia Street
P.O. Box 655
MCC Makati
Rizal

KASAGANAAN INDUSTRIES, *130*
San José
Mindore Occidental

KATO INTERNATIONAL, *129, 130*
92 P. Santiago Street
Malinta
Valenzuela
Metro Manila

KAUNLARAN INDUSTRIES, *129, 130, 147*
Calamba
Laguna

L.P. ENGINEERING SERVICES, *129, 130*
San José
Baliwag
Bulacan

LIM'S ENTERPRISES, PETE, *64, 126, 129*
San Francisco
Augusan del Sur
Cable: PETELIM

MAKATI MACHINERY & EQUIP. CO. INC., *239*
1142 Pres. E. Quirino Avenue
Paco
Manila

MALANDAY MACHINERY & MFG. COR., *239*
15 Gen. MacArthur Highway
Sumilang Subdivision
Dalandanan
Valenzuela
Metro Manila

MARINAS MACHINERY MAN. CO. INC., *126*
Rizal Street
Pila
Laguna

MB ENTERPRISES, *129*
IPSTA Bldg.
La Paz
Iloilo City

MBP ENGINEERING, *61, 64, 126*
K.M. 16 MacArthur Highway
Malanday
Valenzuela
Metro Manila

MECHANICAL FACTORS INC., *129, 130*
Ground Floor
Greenhills Dev. Bldg.
710 Shaw Bldg.
Mandaluyong
Metro Manila

METALS ENGINEERING RESOURCES CORPORATION (METERCOR), *239*
E. Magalone Sr. Street
Mandaluyong
Metro Manila

NIBROS MANUFACTURING CORP., *130*
Dona Rosario Heights
Novaliches
Metrol Manila

P.I. FARM PRODUCTS, *29, 126, 129, 130, 136, 147*
K.M. 16 Malanday
Valenzuela
Metro Manila
Tel: 292-2577/2456

PHILIPPINE IRON MFG. CO. INC. (PHILIMCO), *239*
249 J. Teodoro Street
Grace Park
Caloocan City

POYING'S WELDING SHOP, *39, 61, 64, 125, 126, 129, 130, 147, 148, 239*
262 National Hi-Way
Brgy. Anos
Los Baños
Laguna
Tel: 831 9086
Telex: 63199 ETPI MO PN
Cable: POYINGWELD MANILA

REYMILL STEEL PRODUCTS LTD., *110*
Sta. Rose Neova Ecija

ROSMAN MACHINE SHOP, *126*
Valencia Bukidnon
Magarao
Camarines Sur

SABIO AGRICULTURAL EQUIPMENT, *129*

SEA COMMERCIAL CO. INC., *157*
3985 R. Magsaysay Blvd.
Sta. Meas
Manila 2806
Tel: 611521
Cable: SEACOM MANILA

SEACOM INDUSTRIAL CORPORATION, *106*
30 Scout Tuason Street
Diliman
Quezon City

TECHNO-ADAPTORS INC., *129, 130*
San Isidro
San Fernando
Pampanga

TRYME AGRO-INDUSTRIES, *129*
Lumbia
Pagadian City

2 M INDUSTRIAL COMPANY, *126*
San Mateo
Isabela

VICMAC CORPORATION, *130*
Mandalagan
Bacolod City
Negros Occidental

V & L AGRICULTURAL MACHINERY, *129*
Rizal Street
La Paz
Iloilo City

YAMAKIKI MANUFACTURING, *239*
131 Atlas Road
Bo. San Bartolome
Novaliches
Quezon City

POLAND

All equipment manufactured in Poland which is mentioned in this Guide is marketed through Agromet Motoimport. For readers' information references to the individual factories are also provided.

AGROMET MOTOIMPORT, *18, 19, 22, 23, 43, 44, 66, 68, 78, 123, 124, 148, 162, 163, 179*
Foreign Trade Enterprise
P.O. Box 990
Warsaw
Tel: 28-5071
Telex: 813665
Cable: MOTORIM

AGROMET, *124*
FMR
Strzelce Opolskie

AGROMET DOLZAMET, *163*
Zaklad Elementow Specjaliz Owan YCH=
Ul Kolejowa 25
59-520 Chojnow

AGROMET KMRL, *148*
Lublin

AGROMET KMRL, *162*
Zaklad Produkcji Sieczkarn
Rzulow

AGROMET KRAJ, *66*
Fabryka Maszyn Rolnizych
99-300 Kutno
Ul Swierczenskiego 5

AGROMET UNIA, *18, 22*
Fabryka Maszyn Rolniczych
Ul Petrowskiego 16
86-300 Grudziaoz

AGROMET ZAKLADY KUZIENNICZE, *44*
6 Maszyn Rolniczych
59-400 Jawor
Kuziennicza 4

AGROMET FAMAROL, *123*
Ul Poznanska 1
76-200 Stupsk

METALOWA SPÓLDZIELNIA PRACY 'DUNAJEC', *19*
Nowy Sacz

PAŃSTWOWY OŚRODEK MASZYNOWY, *162*
Rudniki

POWOGAZ, *123*
F-ka Aparatury i Vrz Komunalnych
Pita

WYTWÓRNIA URZADZEŃ KOMUNALNYCH, *23, 43, 124*
Kalisz
Ul Wroclawska 26

ZAKLADY WYVOBOW METALOWYCH 'STRUMET', *179*
43-420 Strumien
Ul Ks. Londzina 323

PORTUGAL

COMPANHIA INDUSTRIAL DE FUNDIÇÃO, *20, 160*
17 Rue de São João 27
4000 Porto
Tel: 24927
Cable: ARADOS

FERFOR (EMPRESSA INDUSTRIAL DE FERRAMENTOSE FORJACOS SARL), *13, 15, 16, 122, 176, 178, 234*
Apartado 16
4466 S Mamede de Infesta Codex
Tel: 952066
Telex: 22262 FERFOR P
Cable: FERFOR

SENEGAL

SISMAR, *19, 20, 22, 23, 43, 51, 54, 63, 64, 66, 103, 127, 128, 134, 148, 149, 153, 158, 160, 180, 181, 182*
B.P. 3214
20 rue Dr. Theze
Dakar
Tel: 51.10.96
Telex: 7781 SISMAR SG

SIERRA LEONE

SIERRA LEONE WORK OXEN PROJECT, *52*
P.M.B. 766
Freetown
Telex: 3418 PEMSU SL (ATTN. WORK OXEN PROJECT)

TIKONKO AGRICULTURAL CENTRE, *237, 238, 239, 240*
Small Farm Equipment Unit
P.O. Box 142
Bo

SPAIN

AGRIA HISPANIA S.A., *238*
Apartado 26
Amorebieta
(Vizcaya)

APICENTER S.A., *220*
Vizcaya 383
Barcelona 27
Tel: 340 74 92

AUGUST PERPINYA, *220*
Carretera L'Hospitalet 45
Cornellá
Barcelona
Tel: (93) 377 00 75

BOMBAS BORJA S.L., *239*
Avenida P. Emilo Baro 25
Peterua
Valencia
Tel: (96) 132 12 00

CAMBYD S.L., *238*
Avenida de Castellón 29
Villarreal
(Castellón)

SPAIN contd.

CAVADOROS LLAC, *238*
San José 74-76
Villarreal
(Castellón)

CONSTRUCCIONES MECÁNICAS 'BTR', *238*
Avenida General Primo de Rivera 27
Algemesi
(Valencia)

EDELMIRO VAZQUEZ Y HNO. S.L., *15, 16, 37, 197, 234*
Apartado 64
Avenida de Vigo 126
Pontevedra
Tel: (986) 85 99 61 85 20 65

GANAL, *193*
Calle Real de Madrid (S/N)
Apartado 17
Silla
(Valencia)
Tel: 120 15 54

INDUSTRIAS MECÁNICAS CONDOR S.A., *238*
Clull 93
Barcelona

INDUSTRIAS MECÁNICAS PALAZON, *238*
Médico Esteve 16-18
Valencia

MACAPER, *238*
Senda Peix Caors 3
Villarreal
(Castellón)

MACESA -MAQ. CEREXA S.A., *154, 198*
Camino de Iturrigorri 3
Bilbao 2
Tel: 4441104 08 12
Telex: 32278 CZO-E

MECÁNICA MOLLON, *238*
Puigcerba 4-6
Molins De Rei
(Barcelona)

MIELSO S.A., *220*
Polígono Industrial El Mijares
Calle No. 7 Apartado 38
Almazora
(Castellón)
Tel: (964) 56 03 00

MODERNA APICULTURA S.A., *220*
La Apartado 9.008
Madrid 28
Tel: 274-52 40/41 81
Telex: 27307-22034-23261-43229

MOTORCULTORES HERSI S.L., *238*
General Mola 53
Alcira
(Valencia)

MOTORCULTORES PASCUALI S.A., *238*
Apartado 132
Rubi
(Barcelona)

MOTORES SOLO S.A., *238*
Vilaborrat 165
Barcelona

MOTOR IBERICA S.A., *238*
Zona Franca
Sektor B
Calle 3
Barcelona 4

OVAL S.A., *238*
Marqués de Duero 75
Barcelona 4

PIVA MOTOR S.L., *238*
Avenida de Madrid 51
León

RAYGAR S.A., *238*
18 de Julio 45
Villarreal
(Castellón)

TALLERES BRONCO S.L., *238*
Valencia 20
Villarreal
(Castellón)

TERBU S.A., *238*
Hospital 44
Villarreal
(Castellón)

TRUSS S.L., *238*
Avenida del 18 de Julio 133
Villarreal
(Castellón)

VICENTE MENDI POZO, *220*
Avda. España 4
Logroño
Tel: (941) 23 73 95/23 63 80

SRI LANKA

CEYGMA PUMPS, *235*
675 Baseline Road
P.O. Box 487
Colombo 9
Tel: 598436
Telex: 21355 NATRUB CE

FARM MACHINERY RESEARCH CENTRE, *37, 38, 39, 40*
Maha Illupallama
Tel: 598436
Telex: 21355 NATRUB CE

JINASENA LTD., *64, 235*
4 Hunupitiya Road
P.O. Box 196
Colombo
Tel: 26558
Cable: SINHA COLOMBO

LIGHT ENGINEERING INDUSTRIES (PTE) LTD., *64, 127, 180, 240*
127 Kottawa Road
Nugegoda
Tel: 552090
Telex: 22015 FWDAIR CE (ATT.DLE)

MAHINDRA ENTERPRISES, *61, 62, 68*
507 Prince of Wales Avenue
Colombo 14
Tel: 32410
Cable: SWIGSON

SAMUEL SONS & CO. LTD., *111*
164 Messenger Street
Colombo 12

SARVODAYA KANDY, *178, 179, 237, 238, 239*
Palletalawinna
Katugastota
Kandy

SATHIYAWADI STORES & MOTOR TRANSPORTERS LTD., *22, 137, 181, 182*
P.O. Box 42
21 Dambulla Road
Kurunegala
Tel: 22388
Cable: SATHIYAWADI

SOMASIRI HULLERS MANUFACTORY, *104, 149, 156, 157*
18 Parakrama Avenue
Kohuwala
Nugegoda
Tel: 073 2258
Cable: SOMASIRI NUGEGODA

TOOLS AND AGRICULTURAL MACHINERIES LTD., *156 157*
53 Vidyalankara Bld. 3rd Fl., 1st Div.
P.O. Box 1940
Colombo 10
Tel: 22818 + 562676
Telex: 21819 AEGRP CE

WALKER & SONS CO. LTD., *163*
P.O. Box 166
Colombo
Tel: 32845
Telex: 1118 COLOMBO
Cable: WALKERS COLOMBO

WELISARA AGRICULTURAL IMPLEMENT COMPANY, *37, 38, 39, 40*
Welisara
Ragama

WIND ENERGY UNIT, *110*
Water Resources Board
2A Gregory's Avenue
Colombo

SWAZILAND

NATIONAL INDUSTRIAL DEVELOPMENT CORPORATION OF SWAZILAND, *30*
Tinkabi Tractor Project
P.O. Box 450
Manzini
Tel: 52141
Telex: 2127 WD
Cable: TINKABI MANZINI

SWEDEN

BRUZAHOLMS BRUK, AB, *109*
570 34 Bruzaholm

ALFA LAVAL AB, *198, 199*
P.O. Box 1008
211 03 Lund
Tel: (046) 105000
Telex: 32145 ALLUNDS

OSCAR GUSTAFSSON & CO., *220*
Biredskapsfabrik AB
4385 Tofta
432 00 Varberg

HEBE STÅL AB, *220*
Fack 32 684/01 Munkfors
Tel: (0563) 52151

JONSEREDS MOTOR AB, *232*
433 81 Partille
Tel: (031) 720300
Telex: 21212

NIBE-VERKEN AB, *63*
P.O. Box 14
285 00 Markaryd
Tel: (0433) 11200
Telex: 72497 NIBE S

NORBERGS, SPAD & REDSKAPSFABRIKER, AB, *13, 24, 37, 38, 122, 173, 178*
Vintergatan 7
591 32 Motala
Tel: (0141) 50065
Telex: 64904 SPADE S

SANDVIK AB, 37, 122
811 81 Sandviken
Tel: (14626) 260000
Telex: 47144 SANDVIKS
Cable: SANDVIK SANDVIKENSWED

WELLDRILL SYSTEMS AB, *103*
Tagenvägen 21
425 90 Hisings Kärra
Tel: (4631) 570260
Telex: 27329 WDRILLS

SWITZERLAND

BIENEN-MEIER, 220
5444 Künten (AG)

BIRCHMEIER & CO. LTD., *78, 80, 85, 88, 91*
5444 Künten
Tel: (056) 96 01 21
Telex: 58 197 BIRAG CH
Cable: BIRAG

FISCHER S/A, *85, 87, 88*
1801 Fenil-Vevey
Tel: (021) 51 32 43
Telex: FISA CH 451 141

HEINIGER & CO., *210*
Hertzogenbuchsee
C.H. 3360
Tel: (041 63) 614545

TANZANIA

JANDU PLUMBERS, *109*
P.O. Box 409
Arusha
Tel: 3410
Telex: 42093 JAPCON

MANIK ENGINEERS, *154*
P.O. Box 1274
Arusha
Tel: 3520
Telex: 42126

MOROGORO WELLS CONSTRUCTION PROJECT, *239*
P.O. Box 261
Morogoro

UBUNGO FARM IMPLEMENTS LTD., *158*
P.O. Box 20126
Dar-es-Salaam
Tel: 53146
Telex: 41206 DAR-ES-SALAAM
Cable: MAJEMBE

UNITED ENGINEERING WORKS LTD., *154, 156*
P.O. Box 3082 Factory Area
Arusha
Tel: 3424

ZANA ZA KILIMO LTD., *16, 18, 22, 122, 176, 178, 234*
P.O. Box 1186
Mbeya
Tel: 2226
Telex: 51133
Cable: ZANAKILIMO

THAILAND

BAN TOOM INDUSTRY, *238*
253 Moo 4 T. Ban Toom
A. Muang
Khon Kaew

BOON KONG KARNCHANG FACTORY, *238*
A. Muang
Petchaburi

CHAI AMNAT KARNCHANG, 239
Phrom Prasert Road
A. Muang
Chainat

CHAIPRADIT KARNCHANG, *61*
235 Moo 8 Chiang Mai-Hang Dong Road
A-Hang Dong
Chiang Mai

CHAMLONG KARNCHANG FACTORY, *238*
Nr. Klong & Bridge
T. Lam Pak Kood
A. Thanyaburi
Pathumthani

CHAROEN KARNCHANG, T., *240*
Moo 22 T Tat
A. Warin Chumrab
Ubon

CHAROENPHAN FACTORY, *238*
710 Moo 1 Paholyothin Road
T. Klong Kung
A. Klong Kung
Kampaeng

CHAROEN TRACTORS, *238*
Between Klong 2 and Klong 3
A. Thanyaburi
Pathumthani

CHIN CHAROEN YONT, *240*
74/20-21 Chaiyangkoon Road
A. Muang
Ubon

CHOK CHAROEN, *18, 24, 29, 238, 240*
724/5 Kor Po-thong Road
A. Muang
Chonburi

THAILAND contd.

CHOK PAIBOON, *238*
6-12 Bang Kla-Plaeng Yao Road
A. Pang Kla
Chachoeng

CHOW THAI KARNCHANG, *238*
Sam Yaek Krachub Saeng Chootoe Ra
A. Ban-Pung
Ratchaburi

FARM YUTHANA, *238*
1534 New Petchaburi Road
T. Bang Kapi
Bangkok
Tel: 2526264

FOO HENG FACTORY, *238*
Mahachakpat Road
A. Muang
Chachoen

IAMLOO PO, *238*
44 Samranruen Road
T. Tha Sao
A. Muang
Utaradit

KAEN MONGKOL FACTORY, *238*
31-1 Moo 9 Soi Panichkaln
Thonburi School T. Bang
Pai. Phasi Chareon
Bangkok

KAMPAENG PRADIT FACTORY, *240*
1072-43-45 Charoensuk Road
T. Nai Muang
A. Muang
Kampaengphet

KARUNAI INDUSTRIAL FACTORY, *238*
501 Wat Karunai
A. Pra Pradaeng
Samut Prakarn

KASETCHAI FACTORY, *238*
Taladbang Bueng
A. Suppaya
Chainat

KIETCHAI INDUSTRIAL FACTORY, *240*
608-1 Moo 5 Paholyothin Road
T. Nakornaum
A. Muang
Kampaeng Phet

KIET PANICH INDUSTRY, *239*
Pa Hulyothin Road
A. Muang
Nakoln Sawan

KIT CHAROEN FACTORY, *238*
Moo 9 Chayangkoon Road
T. Mukdaharn
A. Mukdaharn
Nakorn Panom

LEE CHAROENMETRE FACTORY, *238*
12/4 Moo 2T Lam Pak Kood
A. Thanyaburi
Pathumthani

LEK PAIROJ FACTORY, *238*
68/1 Rojana Road
T. Pai Ling
A. Muang
Ayudhaua

LERTCHAI FACTORY, *239*
244/1 Sai Koo Road
A. Praputabat
Saraburi

LIM CHIENG SENG FACTORY, *17, 137*
92-94 Sawanvithee Road
Nakorn Sawan
Tel: 212254

MR LIMSONG TUEY, *238*
273-275 Talad Nong Kung
Ratburnroong Road
T. Wang Chai
A. Nam Wong

MIT CHAROEN KASETPHAN FACTORY, *238*
2 Moo 2 Talad Nong Song Hong
A. Nong Song Hong
Khon Kaen

MIT I-SAN FACTORY, *238*
Moo 10 Ratburana Road
T. Wang Chai
A. Nampong
Khon Kaen

MIT KASET FACTORY, *238*
Putamonton 4 Road
Bangkok

MUANG LOEY RUAMCHANG FACTORY, *238*
51/1-2 Sakol Chieng Khan
T. Koo Pong
A. Muang
Loey

NAN HA FACTORY, *239, 240*
Talad Kradindaen Malaiman Road
Moo 11 T. Huai Kwang
A. Kampaeng Saen
Nakorn Pathom

NOK NOI-KARNKASET FACTORY, *238*
753 Paholyothin Road
Sam Yaek
A. Muang
Chieng Rai

PHRA KHIRI FACTORY, *240*
1808 Soi Pra Mai Mary Chan Road
Bangkok

PIEK SIAM KOLKARN, *238*
2/78 Soi Withayu T. Ban-Ko
A. Muang
Utaradit

PITAK SUNTI-METHANIKUL, *238*
Moo 33 Ratbumroong Road
T. Chumpae
A. Chumpae
Khon Kaen

PLOUGH DI BAN TUM, *238*
Moo 2 150 Wat Po Klang T. Ban Tum
A. Muang
khon Kaew

PONGCHAROEN PANICH FACTORY, *240*
36 Soi Sri Samphan 8
Samsen Nai
Phya Thai
Bangkok

PRADITYONT FACTORY, *238*
39-31 Marupong Road
A. Muang
Chachoeng-Sao

PRASARTPORN FACTORY, *239*
36 Moo 1 Paholyothin Road
A. Praputabat
Saraburi

PRASERTPANICH FACTORY, *240*
A. Muang
Prachin Buri

PRASERTSUWAN INDUSTRY, *238*
621 Moo 6 Don Chedi-Sa Kra-Chum
A. Don Chedi
Suphanburi

PRATEEPKOLKARN, *62*
35/1 Charoenpun Road
T. Thai-IT
A. Muang
Utaradit

PRAYONGKOLKARN FACTORY, *240*
Paholyothin Road
A. Muang
Chieng Rai

PUNNAVITHI RUAMKIT CO. LTD., *238*
776 Jukumvit 101
Bang Chak
Pra Kanding
Bangkok

RUAMKARNCHANG FACTORY, *239*
184-185 Moo 9
Paholyothin Road
T. Kok Samrong
Lopburi

RUNG ROJ FACTORY, *238*
494 Suppakit Road
T-Na Muang
A. Muang
Chachueng-Sao

RUNG ROJ KARN PRADIT, *240*
649 Moo 11 Pitsanulok-Wang-Thong Road
A. Wangthong
Pitssanulok

SA-ANG CHAROENKUL, *238*
159/1 Sri Prat Road
T. Nai Muang
A. Muang
Nakoln Si Thammarat

SAENGTHONG-KARN PRADIT FACTORY, *238*
48/1-3 Chotana Road
A. Muang
Chiengmai

SAENGYONT, K. FACTORY, *239*
49 Saengchoo-Toe Road
T. Ta-Mai
A. Tamaka
Kanchanaburi

SAHA KOLKARN FACTORY, *103*
94-96 Soi Sukapiban 2
Ramintra
Bangkhen
Bangkok

SAHA LIM TIE FACTORY, *29*
217/8 Mahachakpat Road
A. Muang
Chachoengsao

SAKDAKARNCHANG FACTORY, *238*
14-16 Moo 4 Kan Klong 6 Road
T. Klong 6
A. Klong Lueng
Pathumthani

MRS. SAMORN CHARUN-ON, *238*
34.10 Soi Prachunukul
T. Nai Ket Tesaban
A. Phon
Khon Kaen

SIAMYONT FACTORY, *240*
194 Moo 3 Chayangkul Road
T. Pathum
A. Muang
Ubon

SILIP CHAREON FACTORY, *239*
165 Kantang Road
T.-Tap Tieng
A. Muang
Trang

SINGKU INDUSTRY, *238*
501 Wat Kru Nai
A. Pra-Pradaeng
Samut-Prakarn

SRI-U-THON KARNCHANG FACTORY, *240*
4 Moo 1 Arun-Praser Road
T. Mung
A. Amnatcharoen
Ubon

SUKPRADIT INDUSTRY, *240*
Near Wat Nong Ka Paw
A. Klaeng
Rayong

SURIN IAM-MAOTHAVI, *238*
656 Moo 1 Chenchobtit Road
T. Nai Muang
A. Muang
Khon Kaen

TAI LEK CHANG, *238*
1056 Moo 1 Leewan Road
T. Chumpae
A. Chumpae
Khow Kaen

TANG CHIN SENG, *238*
549/3 Moo 1 Samasbumroong
T. Nai Muang
A. Muang
Khon Kaen

THAI AMORN INDUSTRY, *238*
6-7 Moo 9 Suk Sanat Road
A. Pra-Pradaeng
Samut

THAI KOLKARN, *238*
99 Sam Yaek Ton Ma-Muang
T. Ton Ma-Muang
A. Muang
Pet Chaburi

THAI TAVORN, *156*
549/33-36 Satupradit Road
Yannava
Bangkok
Tel: 2840502

THAI U.S.A. INDUSTRIAL FACTORY, *110*
No. 5g/15 Moo 7 Pracharaj Road
Dusit
Bangkok

THANYA ENGINEERING FACTORY, *239*
599 Moo 3
A. Sri Prachum
Suphanburi

VITA VOLUNTEERS IN TECHNICAL ASSISTANCE, *110*
48 Soi Area 1
Phaholyothin Road
Bangkok 4

WACHARAKARN FACTORY, *238*
T. Tamakue
A. Klong Klung
Kampaeng Petch

WANGDEELOHAKIT, *238*
5/11 Moo 8 Soi
22 Suksawat Road
Ratburana
Bangkok

WANPANICH K. FACTORY, *238*
102/2 Mahachakpat Road
A. Muang
Chachdeng-Sao

YILUN CHIENKUL, *238*
128-129 T. Kam Yai
A. Muang
Ubon

YONTKAMPANICH FACTORY, *239, 240*
735/25 Charunsanitwong Road
A. Muang
Ubon

YONTNERAMIT FACTORY, *240*
272/5 Sappasit Road
T. Nai Muang
A. Muang
Ubon

YONTPHISAL FACTORY, *156*
101 Rajdamnern Road
A. Muang
Trang
Tel: 218164/218170

YONTSAENGTHAI FACTORY, *240*
Chayangkul Road
A. Muang
Ubon

TOGO

UPROMA, *19, 24, 42, 181*
B.P. 1086
Lomé
Tel: (21) 66-36
Telex: 5328 CNPPNE TO

TONGA

DEPARTMENT OF AGRICULTURE, *51*
P.O. Box 14
Nuku. alofa

TUNISIA

SOCIÉTÉ LES FONDIÈRES RÉUNIES TUNISIE, *239*
K. 5.5 Route de Sousse
Megrine
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Northants NN10 9SW
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Birmingham B10 0SA
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Hertfordshire EN8 7DR
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Totteridge Road
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Birmingham B11 2AN
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Telex: WILLCOX 338024 BIRCOM G

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Herefordshire HR9 5NE
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H. Cameron Gardner Ltd.
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Glos. GL5 5EX
Tel: (045 383) 2526
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AR 72032

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Telex: TWX910-520-1163 W&GMARKCO

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Tonawanda
NY 14151-5104
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Telex: 64-6985 ALLSAFE BUF

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1204-2956 Hathaway Road
Richmond
VA 23225

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Shelbyville
IN 46176
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Chatsworth
CA 91311

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Applebutter Road
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Telex: 902061 B&G CO PTDV

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P.O. Box 29
Corner Perry 7 Oakwood Streets
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BAKER MONITOR DIVISION, *102, 107*
133 Enterprise Street
Evansville
WI 53536
Tel: (608) 882 5100

BELL, C.S., CO., *133, 150, 152, 154*
170 W Davis Street
Box 291
Tiffin
OH 44883
Tel: (419) 448 0791

BELLOW'S VALVAIR INTERNATIONAL, *231*
200 W Exchange Street
Akron
OH 44309
Tel: (216) 762 0471

BERLIN PAD SHOP, *44*
P.O. Box 270
Rt. 6
Millersburg
OH 44564

BLOSSOM TIME, *227*
P.O. Box 1015
Tempe
AZ 85281
Tel: (602) 971 5300

BOCK'S CATTLE IDENTI. CO., *195*
P.O. Box 614T
3101 Cedar Avenue
Mattoon
IL 61938
Tel: (217) 234 6834

BOWJON INC., *110*
2829 Burton Avenue
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Industrial Place
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NY 14071
Tel: (716) 532 2272

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Whitewater
WI 53190
Tel: (414) 473 2822

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Powell Man. Co. Inc.
Charlotte
NC 28299

COLEMAN GARDEN PLOW MANUFACTURING COMPANY, *30, 238*
Route 8
Dothan
AL 36301
Tel: (205) 677 5411

COLUMBIAN CUTLERY CO. INC., *122, 209*
P.O. Box 123
440 Laurel Street
Reading
PA 19603-0123
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P.O. Box 396
Parowan
UT 84761
Tel: (801) 477 3338/8902

CUMBERLAND GENERAL STORE, *101, 102, 113, 172, 177, 199*
Crossville
TN 38555
Tel: (615) 484 8481

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Hamilton
IL 62341
Tel: (217) 747 3324

DALTON COOPER & GATES CORP., *37, 38 40, 41, 62, 150, 154*
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New York
NY 10001
Tel: (212) 564 2910
Telex: (RCA) 236123 DLT-PLM

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196 Western Avenue
Fond du Lac
WI 54935
Tel: (414) 922 1500
Telex: 26785

DANA, C.H., CO. INC., *191, 194*
Hyde Park
VT 05655
Tel: (1-800) 451 5197

DAVIS, H.C., SONS, MFG. CO. INC., *152*
P.O. Box 395
Bonner Springs
KS 66012
Tel: (913) 422 3000

DECKER MANUFACTURING CO., *133, 195*
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312 Blondeau
Keokuk
IA 52632
Tel: (319) 524 3304

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P.O. Box 848
Beatrice
NE 68310
Tel: (312) 864 9100
Telex: 724353

DIAMOND TOOL & HORSESHOE CO., *192*
477 Madison Avenue
New York
NY 10022
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Bridgewater
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VA

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415 Siglet Street
Springfield
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Tel: (513) 325 5555

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Maple Street
Bristol
IN 46507
Tel: (219) 848 7491

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Export Office
75 West Street
Syracuse
New York
NY

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11511 New Benton Highway
Littlerock
AR 72203
Telex: (391) 113 3709

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Owatonna
MN 55060
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Telex: 510661 8744
Cable: GEIMAR

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MN 55103
Tel: (612) 488 8315

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IN 46571

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Robbinsdale
MN 55422

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North Hollywood
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OH 45404
Tel: (513) 223 7295

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P.O. Box 228
Rt. 1
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Telex: 276253-C of C SEYM

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Telex: 522372 (IP A HOWD)
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New York
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7108 Möckmühl
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Telex: 04 66791
Cable: AGRIA-WERKE

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8591 Thiersheim
Tel: (09233) 8033
Telex: 641177 JWB D
Cable: WAAGENBAUMANN, THIERSHEIM

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8910 Landsberg A. Lech
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Telex: 527 227

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Tel: (0521) 87661
Telex: 932 366 BRABI
Cable: BRAUCKE BIELEFELD

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7056 Weinstadt-Strümpfelback
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Telex: 0724307

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Industriegebiet Weddingstedt
Postfach 1349
2240 Heide Holstein
Tel: (0481) 5085/5086

GLÖGGLER, MARTIN, *194*
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7910 Neu-Ulm Schwaighofen
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Telex: 712370 GLNU D

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Telex: 089424
Cable: GLORIA WADERSLOH

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7056 Weinstadt 2 (Endersbach)
Tel: (07151) 61147
Telex: 7 262 213 APIG D

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6601 Saarbrücken-Bübingen
Tel: (06805) 791
Telex: 4429 119 GUTB D

J. HAIDINGER, *226*
Finkenweg 5
8042 Schleissheim

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Hamburger Straße 209-239
2060 Bad Oldesloe 1
Tel: (04531) 8061
Telex: 261539

HAUPTNER, H., *190, 192, 195, 196, 209, 210*
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5650 Solingen 1
Tel: (021 22) 5.0075.0
Telex: 8514-409 NAHA D
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7033 Herrenberg 1
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Telex: 72 65 467

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4150 Krefeld 12 (Linn)
Tel: (02151) 5740
Telex: 0853608 HENKL D

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Aussenstelle für Bienenzucht
Erlenstraße 9
3575 Kirchain

HINGHAUS MASCHINENFABRIK GmbH, *182*
Kampenstraße 9
4804 Versmold/Westf.
Tel: (05423) 7644
Telex: 941724

HOFMANN GmbH, *181*
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HOLDER, GebR., GmbH & Co., *78, 79, 80, 87, 88*
Stuttgarter Straße 40-46
Postfach 1555
7430 Metzingen
Tel: (07123) 1660
Telex: 7245319
Cable: HOLDER 7430 METZINGEN

IDEALSPATEN BREDT GmbH & CO. KG, *13, 16, 37, 38, 176, 197*
Postfach 265
5804 Herdecke
Tel: (02330) 2035
Telex: 08 239 416
Cable: IDEAL HERDECKE

KLEIN SCHANZLIN & BECKER AG, *109*
6710 Frankenthal
Pfalz
Telex. 465211

KOCK, C., *220*
Hauptstraße 67
7603 Oppenau/Scharzwald
Tel: (078 04) 520

KOSET, *159*
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LUBING MASCHINENFABRIK GmbH, *110*
Postfach 110
2847 Barnstorf
Telex: (9) 41212

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Ludwigsburger Straße 71
7141 Freiberg/Neckar
Tel: (07141) 71075
Telex: 07-264 839 MEST D
Cable: MESTO FREIBURG NECKAR

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Postfach 1260
Max-Eyth-Weg 42
7972 Isny Im Allgäu
Tel: (07562) 676/760
Telex: 7321 524

MÜNGERSDORFF, HONIG, GmbH, *220*
An St. Agatha 37
5000 Köln 1
Tel: (0221) 213870

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Wormser Straße 119
6710 Frankenthal/Pfalz
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Telex: 04/65204 PLATZ D
Cable: PLATZFABRIK

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Tel: (02191) 8547
Telex: 08513 687
Cable: POLAR REMSCHEID

PREUSSAG AG, *105, 235*
Postfach 6009
3150 Peine
Tel: (05171) 4030
Telex: 92670

PUMPENBÖSE KG, *103*
Postfach 1250
Raiffeisenstraße 2
3006 Burgwedel 1
Tel: (5139) 7051
Telex: 921286 NELHE D

PUMPENFABRIK BEYER, *101, 113*
Dorfstraße 25
Ot Wulfsfelde
2361 Pronstorf
Tel: (04506) 282
Telex: 261487 BEYER D

PUMPOMAT H. FREES ING., *110*
Windkraft Zentrale
Lütthörn 51
2330 Eckenförde

RAU, MASCHINENFABRIK, GmbH, *22, 51, 86*
Johannes-Rau-Straße
7315 Weilheim an der Teck
Tel: (07023) 121
Telex: 7267717
Cable: MAFARAU

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Postfach 1107
Sinzheim 7573
Tel: (07221) 8048
Telex: 0781242 RAUCH D.

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Postfach 1170
Hellenpfad
5413 Bendorf/Rhein 1
Tel: (02622) 3061
Telex: 0869 733 REIT D

RIETSCHE, BERNHARD, *225*
Bienengerätefabrik
7616 Biberach/Baden

RÖBER GmbH, *137*
Postfach 1227
Friedrich-Wilhelm-Straße 79
4950 Minden (Westf.) 1
Tel: (0571) 31031/33
Telex: 0978 24
Cable: RÖBER MINDENWESTF.

SCHEHLE, ERHARD & MARKUS, *220*
8999 Maierhöfen/Allgäu
Tel: (08383) 320

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SCHWÄBISCHE HÜTTENWERKE GmbH, *16, 240*
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7292 Baiersbronn-Friedrichstal
Tel: (07442) 2056/2057
Telex: 0764 225
Cable: SHW FRIEDRICHSTAL/WÜRTT.

SEIP, W., *226*
Hauptstraße 34-36
6308 Butbach-Ebersgöns
Tel: (06447) 6605

STANDARD LANDMASCHINEN GmbH, *127, 132, 235*
Postfach 1160
Kreis Uelzen
3118 Bad Bevensen
Tel: (05821) 1034
Telex: 09 1236

STEINZEUG GmbH, *194*
Postfach 40 0560
Max-Planck Straße 6
5000 Köln 40 (Marsdorf)
Tel: (02234) 5070
Telex: 8 89 118 STG D

SUEVIA HAIGES GmbH & CO., *194*
Postfach 1108
Max-Eyth-Straße
7125 Kirchheim Neckar
Tel: (07143) 9031
Telex: 7 24 922

TECHNICAL ASSISTANCE (INTERNATIONAL), *89, 124 159, 160, 161, 162, 233*
Postfach 1224
Vosskuhlenweg 2
2072 Bargteheide
Tel: (04532) 3373
Telex: 261103 TA D
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ISBN 0 946688 36 2

Cover photograph: Jeremy Hartley

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